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Stillwater Basin Evaluation Report

Former Robert E. Derecktor Shipyard/ Coddington Cove

Naval Station - Newport
Newport, Rhode Island

Northern Division
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298
Contract Task Order 0302

December 1998

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December 22, 1998

Project Number 7752

Mr. James Shafer
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10 Industrial Highway, Mail Stop 82
Lester, Pennsylvania 19113

Reference: CLEAN Contract No. N62472-90-D-1298
Contract Task Order No. 0302

Subject: Transmittal of the Still Water Basin Evaluation Report
Former Robert E. Derecktor Shipyard, Naval Station Newport

Dear Mr. Shafer:

Enclosed are four copies of the Still Water Basin Evaluation Report, prepared for the former Robert E. Derecktor Shipyard at the Naval Station Newport, in Newport Rhode Island. You will recall that these investigations were initiated in order to resolve outstanding issues that were identified during the review of the marine ecological risk assessment for this site.

If you have any questions regarding this material, please do not hesitate to contact me.

Very truly yours,

Stephen S. Parker
Project Manager

SSP/

attachment

c: M. Griffin, NSN (w/encl. - 4)
K. Keckler, USEPA (w/encl - 3)
P. Kulpa, RIDEM (w/encl - 4)
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File 7752-8.0 (w/encl. - 1)

STILLWATER BASIN EVALUATION REPORT
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION - NEWPORT
CODDINGTON COVE

W5298200D

STILLWATER BASIN EVALUATION REPORT
FORMER ROBERT E. DERECKTOR SHIPYARD/CODDINGTON COVE

NAVAL STATION - NEWPORT
NEWPORT, RHODE ISLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION - NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 1812BJH
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop # 2
Lester, Pennsylvania 19113-2090

Submitted by:
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Contract Number N62472-90-D-1298
"CLEAN" Contract Task Order 0302

December 1998

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1.0 INTRODUCTION

This report has been prepared under the Comprehensive Long Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-298, Contract Task Order (CTO) 302. The statement of work requires Tetra Tech NUS Inc. (TtNUS) (formerly Brown and Root Environmental) to perform a study of the so-called stillwater basin, an enclosed boat anchorage and dockage area. This area was once part of the Former Robert E. Derecktor Shipyard, and is, in turn, a portion of the Naval Station - Newport (NSN) in Newport, Rhode Island. This report outlines the investigations conducted at this area and their findings.

1.1 SITE SPECIFIC INVESTIGATION OBJECTIVES

The investigation objectives are to assess, and if possible, determine the cause of the apparent lack of indigenous biota in the stillwater basin near Building 42. The investigation objectives were achieved through a focused program of data collection that was based on previous investigation findings and site background information.

The marine sediments of the stillwater basin were investigated previously in 1995 and 1996. The findings of this investigation is presented as the Derecktor Shipyard Marine Ecological Risk Assessment Report (SAIC and URI May 1997) (ERA). The findings of the ERA regarding the area within the stillwater basin were inconclusive: while it appeared that there were low concentrations of chemical contaminants present in the sediment, there appeared to be a lack of indigenous biota within the basin.

This investigation attempted to determine what factor(s) may be influencing the apparent lack of indigenous biota in the stillwater basin. The study included the placement of synthetic media growth plates (artificial structures) suspended in the water column within and outside the stillwater basin which were to provide suitable habitat area for plant and animal colonization. In addition, samples of water from outfalls that discharge into the basin were analyzed to determine chemical content and other biological and physical parameters. Finally, the habitat quality of the substrate was evaluated through plan-view and sediment profile photography. Results from this study are evaluated to determine if there are limiting factors within the basin that may be responsible for the biotic limitation.

Investigation Activities

Three tasks were performed for the stillwater basin evaluation:

1. Synthetic Media Samples - Spring, Early Summer and Late Summer
2. Bottom Sediment Photography
3: Outfall Sampling

1.2 REPORT COMPONENTS

The components of this report were scoped in the work plan for this investigation (B&R Environmental, January 1998). Section 2 of the report describes the investigations performed as scoped in the work plan and modified in the field during execution. Section 3 of the report presents the findings of each of the three components of the investigations. Section 4 of the report summarizes the findings of the investigations.

Raw data, backup information and data reports are presented in the Appendicies, as referenced within the text and as described below:

Appendix A: CD ROM of sediment photography images recorded during the related investigations (Arcview Project V. 3.0).

Appendix B: Summary of Bottom Imaging Scan including:
- Digital photographs of selected areas
- Photo-Remots survey results & selected images
- Location map of survey track lines and reference points

Appendix C: Report of the Synthetic Media Growth Study, SAIC.

Appendix D: Data and validation memoranda from the analysis of the outfall discharge water samples

2.0 SUMMARY OF THE INVESTIGATION

This section describes the technical approach for the investigation procedures, as outlined in the work plan, and modified in the field. A detailed site history and characterization is provided in the Site Assessment Screening Evaluation Report, Former Robert E. Derecktor Shipyard (B&RE June 1997). A thorough ecological description of the marine portions of the site is presented in the Derecktor Shipyard Marine Ecological Risk Assessment Report (SAIC and URI May 1997).

Figure 2-1 presents the location of the site. For this investigation, two areas were closely evaluated to determine differences in their ability to support a benthic community. Two pairs of stations were evaluated, ERA stations 40 and 41, within the stillwater basin, and 25 and 26, located to the north of Pier 2. These areas are shown on Figure 2-2.

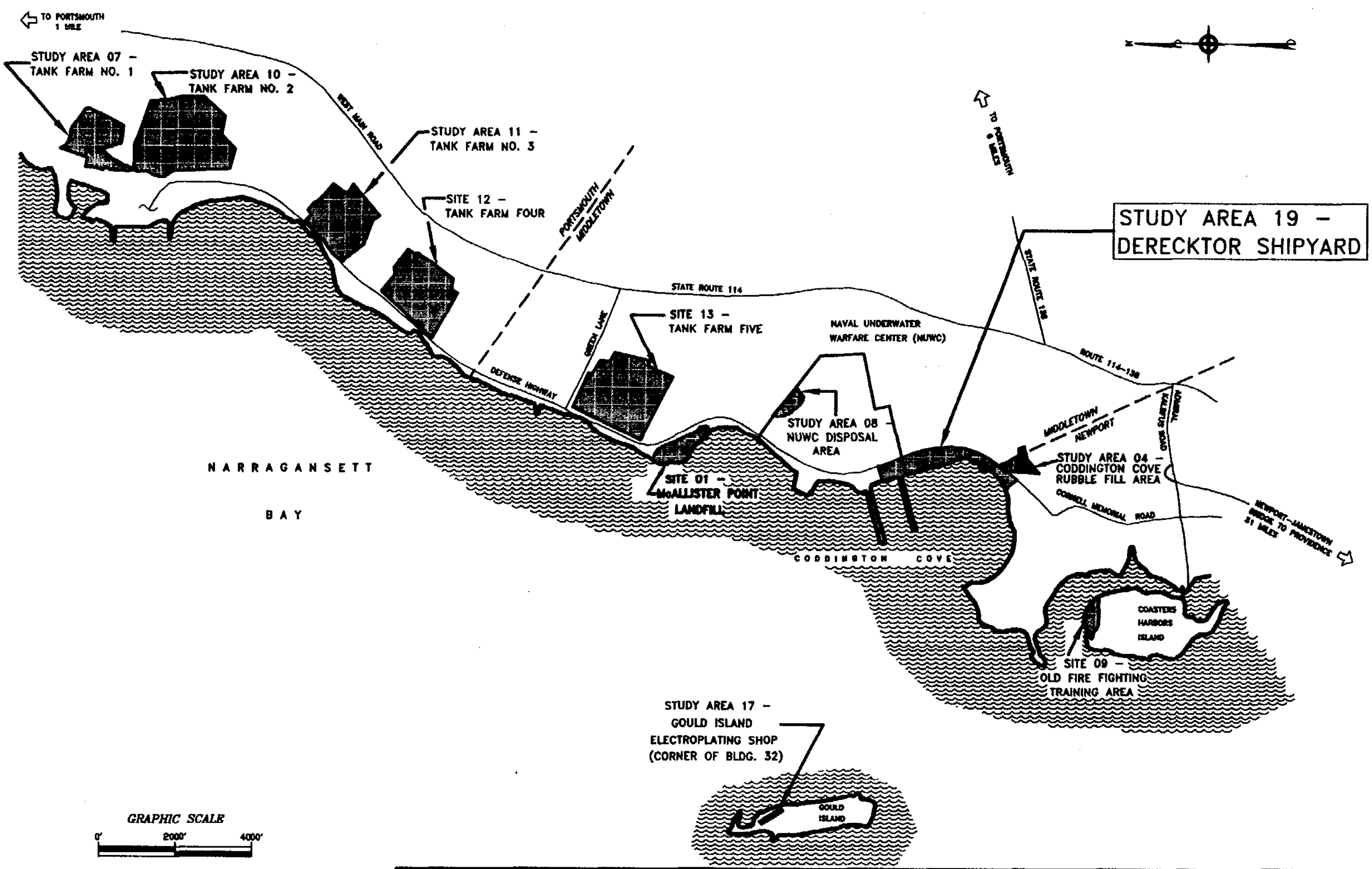
The following subsections describe the investigation tasks performed to make these determinations.

2.1 BOTTOM IMAGE RECORDING

Various image recording devices were used to provide a photographic record of the bottom materials within and nearby the stillwater basin. The purpose of this task was to make a qualitative determination of the presence or absence of biota on the sediments and evaluate the substrate for suitability to provide adequate habitat for benthic and other marine organisms. This effort employed four separate efforts, including plan-view underwater photography, "Remots" sediment profile photography, laser line scan image recording, and side scan sonar image recording.

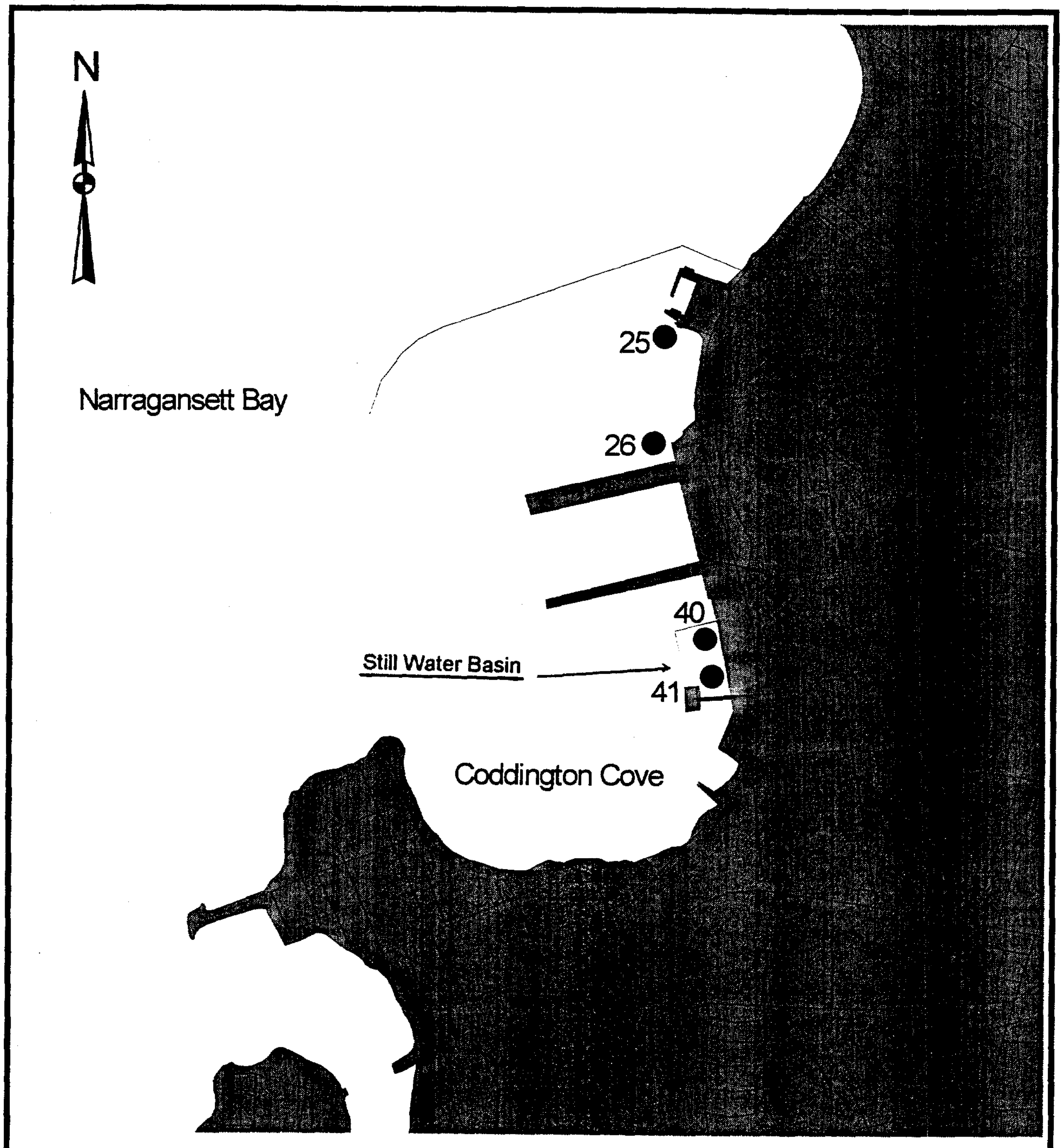
2.1.1 Plan View and Remots Photography

A dual use plan view and "Remots" camera was used to photograph images of the sea floor in the stillwater basin and at the reference area to the North of Pier 2. This device was lowered from a stationary boat, and within one meter of the bottom, a shutter was tripped to photograph the bottom material prior to the camera contacting the sediment.



SITE LOCATION MAP		FIGURE 2-1
DERECKTOR SHIPYARD / CODDINGTON COVE		TETRA TECH NUS, INC.
NEWPORT, RHODE ISLAND		55 Jonspin Road Wilmington, MA 01887 (978)658-7899
DRAWN BY: D. MACDOUGALL / R. DEWSNAP	REV.: 0	
CHECKED BY: S. PARKER	DATE: 25 NOV 98	
SCALE: AS NOTED	FILE NO.: DWG\NAVY\DERECTOR\SASES\SITE_MAP	

DRAFT



NOTE:
1. All Locations To Be Considered Approximate.
2. Plan Not To Be Used For Design.

200 0 200 400 Meters

Sample Stations		FIGURE 2 - 2
Still Water Basin Evaluation Report		TETRA TECH NUS, INC.
Dereckor Shipyard, RI		
DRAWN BY: J. B. Holden	REVISION: 0	55 Jonspin Road Wilmington, MA 01887
CHECKED BY: S. Parker	DATE: 13 Jan 98	(978)658-7899
SCALE: AS SHOWN	FILE: a\Base_map.APR base	

The Photo-Remots camera then photographed the profile of the substrate on which the unit landed. The Remots camera employs a probe that is forced into the sediment to a depth of up to 20 cm, and a photo is taken of the profile of the sediment that is penetrated by the probe. This device was used to collect photographs of the sediment at the four stations where deployments were made. Photo-Remots images are used to evaluate subsurface material by showing a profile image of the sediment to a depth of 15 cm. These images have been used to show zones of bioturbation, macro invertebrate presence, and other strata in the cross-section.

2.1.2 Laser Line Scan and Side Scan Sonar Imaging

Typically, laser line camera technology has been used to survey bottom materials for dredging, recovery and environmental restoration projects. Gravel vs. sand/silt bottom materials can be differentiated, and foreign material (rope, cable, debris, etc.) and macro flora and fauna can be identified.

The Navy attempted to use the laser line camera to collect digital images of the bottom materials within the stillwater basin, and the reference area north of Pier 2. The camera is housed in a large submersible container, designed to be towed behind a ship for deep water mapping. In addition, the camera processes the images that it collects by tracking in straight lines. The constrictions and shallow waters of the stillwater basin and the other areas of interest did not allow time and distance for the camera to focus on the bottom properly. Finally, there was a high level of interference from blue green algaes that were present in the water at the time of the survey.

A similar scan was performed along the length of Pier 1 (both north and south sides), and the sheet piling wall along the Derecktor Shipyard study area. This was performed to quantify and better determine the nature of solid debris which was formerly reported in this area by divers. These solid materials were previously reported to include bicycles, shopping carts, cable, wire, conduit, piping and other metal debris that would impact the cost or performance of a dredging project in this area.

Because the laser camera was not able to obtain all the information intended, a high resolution side scan sonar unit was also used to attempt to identify biota present in the areas of interest. While this unit experienced some of the same difficulties as did the laser line camera, it was smaller and easier to maneuver within the constricted areas of the cove.

Successfully processed images taken from the laser line survey, the side scan sonar survey, and the photo imaging survey are presented in Appendicies A and B of this report.

2.2 BENTHIC COMMUNITY GROWTH

Synthetic media growth disks were deployed at four stations within Coddington Cove to evaluate growth at stations within the stillwater basin to those outside the stillwater basin.

Deployments were placed at two stations in the stillwater basin (40 and 41) and at two stations outside the stillwater basin (25 and 26), but within Coddington Cove as presented in Figure 2-2. Station locations were selected to correspond to locations sampled for the Derecktor Shipyard Marine Ecological Risk Assessment Report (SAIC and URI May, 1997). These stations were selected because the bottom types and depths are similar to stations 40 and 41 and were found by the ERA to have low toxicity and low concentrations of contaminants of concern.

Each deployment array consisted of "Hester-Dende" wooden disks that were suspended in the water column, approximately one-half meter above the bottom. Each deployment consisted of five "strings" (replicates) of 10 disks. This number of disks allows statistical evaluation of differences in growth between stations in the stillwater basin and the other stations outside of the basin.

The deployment was to be placed in early March and allowed to remain for a sixty day period. However, oversight parties were concerned that the arrays may not adequately measure the interference with growth that the sediment might provide because of the distance from the bottom. Therefore, at the end of the first deployment period (May 18, 1998) the arrays were reconfigured with new disks, and replaced a the stations described above. The new configuration allowed two strings of disks on each array to be placed in within 0.05 meters of the sediment surface. Three strings of disks were allowed to remain suspended in the water, approximately one foot from the bottom. Photos presented in Appendix C depict the reconfigured arrays.

The newly configured arrays were placed at the stations as planned, and allowed to remain for a period of 6 weeks, from May 1998 to July 1998. It was anticipated that this period would not span a time when anoxic conditions would be present to affect the growth of the organisms. During this period, biweekly samples were collected for dissolved oxygen and salinity analysis.

A third deployment was made in the same manner as the second deployment, but during a time when anoxic conditions were most likely to occur in the test area. Deployment arrays were configured as requested by the RIDEM, and replaced for another six weeks - July 13 to August 31, 1998. During this period, biweekly samples were collected for dissolved oxygen and salinity testing and remote, self-recording dissolved oxygen detectors were deployed with the arrays.

2.3 OUTFALL SAMPLING

Tetra Tech NUS Inc. collected samples of water from seven outfall pipes that discharge to the stillwater basin at Building 42. The outfalls sampled included those identified in the SASE report as OF#4 through OF#9A. This effort was performed during a rain event to determine the nature of potential contaminants being introduced to the stillwater basin through this system. Figure 2-3 depicts the locations of these outfalls.

The sample collection was performed during a rain event so that the outfalls would be discharging at an adequate rate to collect water for the tests specified that would be representative of water discharging to the stillwater basin. The outfalls are located in the sheet piling wall above the high tide line. The outfall water samples were collected in a stainless steel bucket lowered by a line to the outfall discharge opening, and then allowed to fill for a recorded period of time. The bucket was retrieved and the amount of water collected was measured to determine flow rate. The water samples were immediately transferred to the appropriate sample containers and preserved (if necessary).

Remaining water was tested to determine temperature, pH, specific conductivity, dissolved oxygen, and salinity. It was noted prior to and during collection that the outfalls were very responsive to precipitation, and did not provide discharges when it was not raining.

Water was collected for analysis of TAL metals, PCBs, semivolatile organic compounds (SVOCs), fecal pollution indicators, total suspended solids (TSS), total dissolved solids (TDS), biochemical oxygen demand (BOD), and chemical oxygen demand (COD). Fecal Pollution Indicators include: total and fecal coliforms, fecal streptococci and enterococci, and Clostridium perfringens spores analyses. A total of seven field samples were collected, as well as one "blind" duplicate sample, one MS/MSD, one trip blank, and one field blank. A review of data equivalent to EPA Tier II validation was performed to evaluate data quality.

3.0 FINDINGS OF THE STUDY

The findings of the investigations described in Section 2 are summarized in this section. Original deliverables (reports, data and photographs) are presented in the Appendicies attached.

3.1 IMAGING RESULTS

Underwater imaging was used to better characterize the bottom materials. In addition to Remots and plan view photography, which were employed to evaluate the characteristics of the habitat provided by the sediment, a large number of images were captured with laser scan imaging, and a large portion of the bottom was also scanned again with side scan sonar imaging. Images from this effort are presented in Appendix A on CD ROM in Arcview Project format. This CD ROM provides an interactive visual record of the images collected. This compact disk requires Arcview version 3.0 or above to be effectively viewed. A summary of the field effort and representative images printed from the Arcview files are presented in Appendix B of this report.

Plan view and Remots images were interpreted with the findings of the synthetic media deployments, presented in Section 3.2 and Appendix C of this report. This effort found a variety of substrate in the stillwater basin and reference area, but noted in particular that a sand-bottom environment is more prevalent in the stillwater basin than in the reference area, and the lack of suitable substrate for sessile organisms probably contributes to the lack of biota in this area.

Laser scan imaging was performed in order to determine the nature of the substrate around the piers and other portions of the cove in February 1998. This effort provided a number of images that were used to characterize the bottom and debris within the study area, focusing on the bottom near the piers and the bulkhead areas. The resolution of the images collected is poor, but a number of targets were identified. A summary of the images that were recorded is presented as Table 1, Appendix B.

Side scan imaging was performed in March 1998 to augment the laser scan images that were collected as described above. The side scan images also showed debris and different bottom substrates. The images confirmed the assessments made in the marine ecological risk assessment, showing some sandy bottom areas, and some hard bottom areas, as well as some debris including rope, cable, pipe, and other debris along the piers and bulkheads.

The debris that is present can be removed using most dredging equipment available to industry. However, it should be noted that suction dredging, which is scoped in the Draft Feasibility study for the site would not remove all the debris present in this area. The stone and other material greater than 6 inches diameter would not be removed by this technology, and other means would have to be used to capture it if retrieval was necessary. Finally, it is advised that the images gathered during this survey be studied carefully as a part of a pre-design investigation that would be performed as a part of any dredging action in this area.

3.2 STILLWATER BENTHIC COLONIZATION POTENTIAL

The colonization potential for the benthic community was evaluated as described in Section 2.1 and 2.2 of this report. The evaluation included plan view photography of the bottom sediments, REMOTs photography of the sediment profiles (up to 20 cm) and deployment and analysis of growth plates in at the stillwater and reference stations. This section describes the findings of this evaluation. Images from photos taken are presented in Arcview Project 3.0. The image files are provided on a CD ROM that is presented as Appendix A of this report.

3.2.1 Plan View Photography

Plan view photographs were taken from an underwater camera that is dropped vertically from a boat and takes a still photo from within three feet of the bottom. This method produced good quality photos of the bottom substrate within the stillwater basin and in the area of the reference deployment areas. Plan view photos were taken on April 6, 1998. Image files are provided in Appendix A, as Arcview Project files. In the Arcview project files, there is a map showing locations of the photos taken. The location targets are linked to the image files for viewing.

These images portray sandy and rocky bottom in both areas investigated, and the typical level of biological growth and activity that one could expect from those substrates. Review of the other photographs from within the stillwater basin show that much of the area is sand bottom environment that does not contain substrate suitable for macrophytic algae and sessile organisms typical of the area. However, the small areas that do contain adequate substrate does support the type of community one would expect in a subtidal environment.

3.2.2 Remots Sediment Penetration Photography

The Sediment Profile Camera model 3731 was used to photograph profiles of the sediment – water interface in August 1998. This device is landed on the sediment surface and deploys a probe into the sediment to photograph a side view of the interface. The probe will reach a maximum of 20 cm into the sediment. Using SAIC REMOTS remote sensing techniques, this device can be used to evaluate the underlying physical and biological processes that are present.

This device provides high quality, high resolution photographs of the sediment water interface. However, the photos have no depth of field, so that the only image that can be viewed is what is within six inches of the probe. Example photos using this device are presented in Appendix B of this report.

A full interpretation of the REMOTs observations is presented in Appendix C with the benthic colonization study. In summary, the camera penetration indicated that sediment at depth is more likely composed of sand at stillwater basin than at the reference location, and that there are also some pockets of soft mud at the stillwater basin. Apparent redox potential (RPD) was shallow at the stillwater basin (1.3 cm) vs. the reference area (3.0 cm), although it is not clear whether this is the a result of a lack of bioturbation, or the result of it. The bottom at the stillwater basin was composed of Stage 1 benthic colonization (75% of stations). Stage 1 colonization consists of dense clusters of near-surface dwelling polychaetes, and an absence of bivalves. Stage 1 is typically associated with shallow bioturbation and shallow RPD as was observed. Stage 1 colonization was evident at 65% of the stations in the reference area, indicating that this type of community is not specific to the stillwater area.

3.2.3 Deployment Analysis

The deployments described in Section 2.2 of this report were analyzed and summarized in a report provided to Tetra Tech NUS Inc, which is presented in Appendix C. The report describes the deployments, the field work performed, and statistical analysis of the data collected from the artificial media deployments. The analysis includes species present, abundance and other community structure characteristics. Differences between growth at the stillwater basin stations and the stations outside the stillwater basin were identified and evaluated.

This study revealed that while the environmental quality of the stillwater basin and the reference stations were very similar, and the colonization of the growth plates were similar between the two locations, the habitat of the stillwater basin is less able to support the development of a balanced indigenous community. It appears that the sand bottom that makes up most of the stillwater area is not conducive to development of the community that is present in the reference area.

3.3 OUTFALL SAMPLE RESULTS

This section describes the analytical results from water samples collected from the outfall pipes near Building 42. Samples were collected between May 5 and May 7, 1998. This was the end of a 10 day period of rain and was within the winter deployment period described in Section 2.2 of this report. Three outfalls (DSY-OF04-01, 06-01, and 07-01) that are roof drain outfalls. The remaining outfall pipes are believed to be storm drain runoff (Brown & Root, 1997).

3.3.1 Outfall Discharge Measurements

Water discharged from the pipes was measured at rates from 0.041 to 16.4 gal/min, but it was observed that discharges slowed considerably and stopped when precipitation stopped.

The results for temperature, flow rate, dissolved oxygen, turbidity, salinity, pH, and specific conductance were measured in the field for each outfall pipe (see Table 3-1). The temperature ranged from 12.5 to 15.6 C. Dissolved oxygen content was similar for the roof drain outfalls, from 8.42 to 9.43 mg/l. The storm drain outfalls had more variance, from 5.94 to 10.78. The turbidity of the samples was dependent upon the type of outfall. The roof drain samples, from 0 to 1 NTU, were substantially less turbid than the storm drain samples, which ranged from 25 to 407 NTU. The salinity of water from all outfall pipes was limited from 0 to 0.05 ppt. Water from each outfall pipe sample had a similar pH, ranging from 7.14 to 7.98. The conductivity of each sample ranged from 0.117 to 1.32 mhos/cm.

Table 3-1
Physical Parameters Measured in Outfall Discharge
Still Water Basin Evaluation
Naval Station Newport, Newport, Rhode Island

Type of Outfall	Outfall No.	Sampling Date	Temp. (Celsius)	Rate (gal/min)	Dissolved Oxygen (mg/l)	Turbidity (NTU)	Salinity (ppt)	pH (standard units)	Specific Conductance (mmhos/cm)
Roof Drain	DSY-OF04-01	05/05/98	13	0.041	9.43	1	0.01	7.14	0.333
Roof Drain	DSY-OF06-01	05/05/98	13	0.375	8.42	0	0.01	7.98	0.287
Roof Drain	DSY-OF07-01	05/06/98	12.5	0.075	8.51	1	0	7.24	0.37
Storm Drain	DSY-OF05-01	05/05/98	14.7	0.25	10.78	102	0	7.39	0.144
Storm Drain	DSY-OF08-01	05/06/98	15.6	16.4	7.12	407	0	7.37	0.134
Storm Drain	DSY-OF09-01	05/06/98	12.5	0.75	9.19	25	0.05	7.69	1.32
Storm Drain	DSY-OF09A-01	05/06/98	14.8	7.5	5.94	33	0	7.39	0.117
Storm Drain	DSY-OFDUP-0	05/06/98	12.5	0.75	9.19	25	0.05	7.69	1.32

3.3.2 Chemical Analysis of Water

The water samples collected from the outfalls were analyzed for target analyte list (TAL) metals, PCBs, semivolatile organic compounds (SVOC), fecal pollution indicators, total suspended solids (TSS), total dissolved solids (TDS), biochemical oxygen demand (BOD), and chemical oxygen demand (COD). These results were reviewed using a Tier II protocol as specified in the "National Functional Guidelines for Organic and Inorganic Data Review (USEPA December 1990 (revised). Findings of the validation procedures as well as the validated data are presented in Appendix D of this report.

There were no PCBs detected in any of the samples collected. Three SVOC compounds were detected in the samples (see Table 3-2). Sample DSY-OF04-01 contained 78 *u*g/l of Butylbenzylphthalate. This was also found in the samples from DSY-OF06-01, OF09-01, OFDUP-01. Sample DSY-OF06-01 also contained bis(2-ethylhexeyl)pthalate, and Benzo(b)fluoranthene.

There were 13 TAL metals detected; aluminum, antimony, barium, calcium, iron, lead, magnesium, manganese, mercury, nickel, potassium, sodium, and zinc (see Table 3-2). Barium was only detected in sample DSY-OF04-01, at a concentration of 10.8 *u*g/l. Aluminum, iron, lead, and manganese were only detected in samples from the storm drain outfalls.

Chemical oxygen demand (COD), biological oxygen demand (BOD), and total dissolved solids (TDS) were measured in all outfall samples (Refer to Table 3-3). The storm drain outfall samples showed increased COD and increased TDS from that measured samples taken from the roof drain outfalls. TSS and BOD was not found within measurable levels in the roof outfall samples. All samples from the storm drain outfall contained measurable concentrations of TSS. BOD was found at measurable concentrations in all storm drain outfalls with the exception of DSY-OF-05.

3.3.3 Biological Analysis of Water

Fecal pollutant indicators were present in all samples, although higher amounts were measured in water from the storm drain outfalls than the roof drain outfalls (see Table 3-3). The values for coliforms, streptococcus, and enterococcus are listed as a most probable number (MPN). The MPN is obtained from statistical analysis of the positive and negative results obtained from

Table 3-2
Contaminant Concentrations in Outfall Discharges
Still Water Basin Evaluation
Naval Station - Newport, Newport Rhode Island

EPA Sample Number	DSY-OF04-01	DSY-OF05-01	DSY-OF06-01	DSY-OF07-01	DSY-OF08-01	DSY-OF09-01	DSY-OF09A-01	DSY-OFDUP-01
Date Sampled	5/5/98	5/5/98	5/5/98	5/6/98	5/6/98	5/6/98	5/6/98	5/6/98
Date Extracted	5/11/98	5/11/98	5/11/98	5/11/98	5/11/98	5/11/98	5/11/98	5/11/98
Date Analyzed	5/20/98	5/14/98	5/19/98	5/20/98	5/20/98	5/23/98	5/23/98	5/23/98
Type of Outfall	Roof Drain	Storm Drain	Roof Drain	Roof Drain	Storm Drain	Storm Drain	Storm Drain	Storm Drain
Aluminum	93.3 U	671	44.8 U	56.0 U	4250	213 U	314 U	252 U
Antimony	6.2	2.3 U	2.4 J	2.3 U	2.6 J	2.3 U	2.3 U	2.3 U
Barium	10.8	21.0 U	10.8 U	10.8 U	24.5 U	10.2 U	9.8 U	9.1 U
Calcium	40000	11700	39400	3540	12200	20600	9710	21200
Iron	102 U	1600	71.7 U	54.7 U	9560	657	613	676
Lead	3.6 U	9.7	1.7 U	2.2 U	41.8	1.7 U	5.8 U	5.2 UJ
Magnesium	4060	2740	2420	523 U	4080	22100	2320	22300
Manganese	5.8 U	37.3 J	5.0 U	7.5 U	202	51.4	22.7 U	51.4
Mercury	0.13 J	0.27	0.13 U	0.41	0.13 U	0.47	1.5	0.13 U
Nickel	6.8 U	6.8 U	6.8 U	7.0 J	17.0 J	6.8 U	6.8 U	6.8 UJ
Potassium	10400	2150	5180	368 U	2380	8670	1960 U	8580
Sodium	17300	12800	10700	3070	12500	174000	9290	176000
Zinc	106	46.1 U	34.0 U	81.8	116	8.3 U	16.7 U	8.8 UJ
Butylbenzylphthalate	78	20 U	3 J	10 U	10 U	4 J	10 U	5 J
bis(2-Ethylhexyl)phthalate	20 U	20 U	1 J	10 U	10 U	10 U	10 U	10 U
Benzo(b)fluoranthene	20 U	20 U	1 J	10 U	10 U	10 U	10 U	10 U

Note: U - Not Detected; UJ - Detection Limit Approximate; J - Quantitation approximate

Table 3-3
Biological Parameters Measured in Outfall Discharge
Still Water Basin Evaluation
Naval Station - Newport, Newport Rhode Island

EPA Sample Number	DSY-OF04-01	DSY-OF05-01	DSY-OF06-01	DSY-OF07-01	DSY-OF08-01	DSY-OF09-01	DSY-OF09A-01	DSY-OFDUP-01
Date Sampled	5/5/98	5/5/98	5/5/98	5/6/98	5/6/98	5/6/98	5/6/98	5/6/98
Outfall Type	Roof Drain	Storm Drain	Roof Drain	Roof Drain	Storm Drain	Storm Drain	Storm Drain	Storm Drain
Biochemical Oxygen Demand	2 U	2 U	2 U	2 U	5.7	4.6	5.8	4.3
Chemical Oxygen Demand	9.6	24.9	32.2	12.2	56	52.9	53.7	51.4
Total Dissolved Solids	206	92.5	164	27.5	101	614	90	620
Total Suspended Solids	5 U	18	5 U	5 U	133	7 J	6	5
Total Coliform MPN/100 ml	900 J	*1600 J	240 J	*1600	*1600	*1600	*1600	*1600
Fecal Coliform MPN/100 ml	900	*1600	30	*1600	*1600	*1600	*1600	*1600
Fecal Strep MPN/100 ml	500	*1600	30	*1600	*1600	*1600	*1600	1600
Enterococcus MPN/100 ml	500	*1600	30 U	*1600	*1600	*1600	*1600	1600
Clostridium Perfingens CFU/100	29	11	1 U	1	300	210	1000	160

Note: All values marked with an * are greater than or equal to the number.
U - Not Detected; UJ - Detection Limit Approximate; J - Quantitation approximate

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multiple testing. All values of total coliform, fecal coliform, fecal strep and enterococcus were equal to or greater than 1600 MPN/100 ml of the water in the samples from the storm drain outfalls. The clostridium perfringens ranged in value from 11 to 1000 CFU/100 ml for the storm outfalls. The results from the roof outfall were variable for each pipe. The highest levels were found in sample DSY-OF07-01, which contained the same levels as the storm outfall samples. Sample DSY-OF04-01 had lower levels of all fecal pollutants except Clostridium Perfringens. The lowest levels of these bacteria were found in the roof drain outfall sample DSY-OF06-01.

4.0 SUMMARY

This study was initiated to answer questions about the stillwater basin that were raised during the review of the Ecological Risk Assessment Report for Derecktor Shipyard and Coddington Cove. The questions centered on the lack of indigenous biota in the stillwater basin. This study used a number of evaluations to consider the reason for the lack of biota.

The findings of the evaluations indicate that the substrate (soft sand with low oxygen at depth) does not provide the optimum habitat for what some might look for in a subtidal benthic community. However, a so called "Stage 1" community does exist, living within the limitations that are present. Limitations include introduced bacteria from outfalls, low oxygen in sediment at depth, restricted circulation of water, and a sandy bottom substrate that is likely a result of the hydrodynamics of the area.

In addition, the nature of the subtidal environment was previously altered from the natural condition by dredging and construction of the pier structures and breakwater. A less than optimal community in an area altered in this way should be expected.

Overall, the evaluations performed do not indicate a significant stress to the marine environment in the stillwater basin, as compared to the reference stations. While engineering measures should be taken to reduce the flow of bacteria to this area, it is not likely that such an action would result in any immediate change in successional stage of the benthic community in the stillwater basin.

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APPENDIX A
CD ROM: MARINE SEDIMENT IMAGE FILES (ARCVIEW 3.0)

APPENDIX B
IMAGING SURVEY OF THE SEA FLOOR OF DERECKTOR SHIPYARD/CODDINGTON COVE, SAIC, OCTOBER 1998.

Imaging Survey of the Seafloor

of Derecktor Shipyard/Coddington Cove

October, 1998

Prepared for:

Tetra Tech NUS
55 Jonspin Road
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Prepared by:

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Narragansett, RI 02882

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1.0. Introduction

Side scan sonar, laser line scan, planview photography, and sediment profile imaging surveys were conducted in the vicinity of Derecktor Shipyard/Coddington Cove, Narragansett Bay, RI in order to characterize seafloor topography in relation to potential hazards to vessels or equipment which might be employed for purposes of sediment remediation.

1.1. Derecktor Shipyard/Coddington Cove side scan sonar survey.

A side-scan sonar survey was recently performed in Narragansett Bay offshore of Derecktor Shipyard/Coddington Cove. This report describes the technology, methods of data collection, and provides a summary of information extracted to date from the records, focusing primarily on the distribution of large objects which would interfere with remedial actions that might be necessary at the site.

Survey Design. Side scan sonar operations were performed over three separate survey grids on 21 and 22 February as well as 17 March 1998 to provide images of the seafloor in selected areas of Derecktor Shipyard/Coddington Cove. Water depths in the survey areas ranged from 20 m at the western margin to approximately 2 m in close proximity to the shore. A 300 kHz Sea Scan PC system, manufactured by Marine Sonic Technology, Ltd., was used to produce enhanced-resolution images of the seafloor to aid in target differentiation and identification. Survey lanes in deeper water were spaced at 20 m intervals and side scan sonar data were collected over a 50-100 m swath to provide bottom coverage in excess of 150%. As water depths decreased, the survey lanes spacing was also reduced to maintain comprehensive coverage of the seafloor.

Navigation. Differential Global Positioning System (DGPS) data in conjunction with SAIC's Portable Integrated Navigation and Survey System (PINSS) were used to position the survey vessel and side scan towfish along predetermined survey lanes. The broadcasted US Coast Guard differential beacon corrections at Montauk Point, New York (293 kHz) were utilized for satellite corrections due to its geographic position relative to Narragansett Bay. When merged with the satellite data, the correctors provide differential GPS positions to an accuracy of ± 3 m with an update rate of 1 Hz.

Data Processing. All side scan sonar data were collected and stored within the Sea Scan PC system as modified Tagged Image File (*.TIF) with navigation information embedded within the file format. The data were post-processed through Marine Sonic Technology's Sea Scan PC review program to extract position, as well as to permit identification and measurement of sonar contacts. The locations and heights of targets were determined via slant range calculations (triangulation) based on the position and altitude of the towfish as well as the relative length of sonar shadows. Upon completion of data processing activities, all pertinent modified *.TIF files were exported to a standard *.TIF format for incorporation into an ARCVIEW project.

Survey results. Figure 1.1-1 shows the center trackline plots for each of 6 areas in which the side scan sonar was towed over three survey days; as noted above, a fairly complete coverage of the seafloor for these regions are provided by these specifications. Example side scan sonar images collected in the survey area (Figure 1.1-2) inshore and offshore of Derecktor Shipyard/Coddington Cove are shown in Figure 1.1-3a and Figure 1.1-3b, respectively. In Figure 1.1-3a, numerous large objects are observed but do not appear to be man made, given the lack of angular feather or recognizable distribution patterns. In contrast, Figure 1.1-3b depict a very large object of 10-20 m in length, which is obviously man-made or would appear to be a sunken barge or platform. Complete side scan sonar imagery is included as an ARCVIEW project on CD-ROM medium. From this imagery, the distribution of seafloor targets and their associated heights were determined. Target size varied from small objects < 0.5 m in height, to very large objects up to 2.5 m tall (Figure 1.1-2). The maps show that the presence of objects < 1 m is common for the study area; larger objects tend to be located closer to piers and pilings which may be related to shipyard activities.

1.2. Derecktor Shipyard/Coddington Cove photographic characterization study.

A limited plan view photographic survey of Derecktor Shipyard/Coddington Cove was conducted to search for the surficial expression of man-made debris or otherwise characterize bottom habitat. This section summarizes information extracted to date from the photographic records, focusing primarily on the distribution of habitat type and debris.

Survey Methods. Photographic survey operations were performed on 6 April 1998. A Photosea camera system including two submersible flash units and 100-frame film packs was deployed in a weighted PVC frame and electronically tethered to a topside computer for camera control and collection of positioning data (See Section 1.1 for description of the navigation system). The Photosea system was used to collect approximately 150 1 m^2 plan view images of the seafloor in water depths of 5-10 m in the eastern portion of Derecktor Shipyard/Coddington Cove study area.

Data Processing. All photographic data were collected and stored on 35 mm color film, processed as slides, scanned at 600 x 800 pixel resolution, stored as JPEG images and brought into an image editing software (Photoshop) for minor contrast and brightness adjustments. Subsequently, imagery was integrated with navigation data into a PC ARCVIEW project and images were reviewed for habitat characteristics and classified as to habitat type. Complete Photosea imagery is included as an ARCVIEW project on CD-ROM medium.

Survey Results. Figure 1.2-1a shows the location of Photosea images and inferred benthic cover south of the YP Pier in northeastern Derecktor Shipyard/Coddington Cove. From this imagery, five representative classes of habitat were observed, including 1) macrophytic algae (Figure 1.2-2a), 2) shells and macrophytic algae (Figure 1.2-2b), 3) sand, macrophytic algae, and a blue crab (Figure 1.2-2c), 4) sand and macrophytic algae (Figure 1.2-2d), and 5) sand bottom (Figure 1.2-2e). Careful review of the images failed to reveal evidence of man-made debris at the surface in the surveyed area.

1.3. Derecktor Shipyard/Coddington Cove sediment-profile characterization study.

Sediment-profile photography and computer image analysis has been conducted at the Derecktor Shipyard/Coddington Cove study area using a system called REMOTS (Remote Ecological Monitoring of the Seafloor) (Rhoads and Germano 1982, 1986). This is a remote sensing technique which allows inferences to be made about underlying physical and biological processes (sediment, grain-size, fabric, depth of mixture, and community structure), which in turn can be used for mapping or to make judgments about the health or quality of the observed benthic system (Valente et al. 1992). A model 3731 Sediment-Profile Camera (Benthos, Inc., North Falmouth, Massachusetts), designed to obtain undisturbed in situ profile images of the top 15-20 cm of sediment, was used. During REMOTS image analysis, measurements of physical and biological parameters can be made both directly by visual observation of a life-size positive print. This section summarizes information focusing primarily on the visual appearance of the sediment profile; more quantitative analysis will be discussed as part of the Stillwater Basin investigation (SAIC, in prep).

Survey Methods. Photographic survey operations were performed on 13 and 17 July 1998. Functioning like an inverted periscope, the REMOTS camera consists of a wedge-shaped prism with a front face plate and a back mirror mounted at a 45 degree angle to reflect the profile of the sediment-water interface up to the camera. A 35 mm camera is mounted horizontally on top of the prism. Once the prism comes to rest in the sediment, a photo is taken. The REMOTS was used to collect images of the sediment-profile in water depths of 5-10 m in the eastern portion of the Derecktor Shipyard/Coddington Cove study area.

Data Processing. Cola film was used at all sampling locations on this survey; the film was developed at the end of each field day to verify proper equipment operation and that all necessary data were collected. Measurements of all physical parameters and some biological parameters are obtained directly from the film negatives or positives using a video digitizer and computer image analysis system. The image analysis system can detect over 16.7 million shades of color, therefore subtle features are accurately digitized and measured. Complete REMOTS imagery is included as an ARCVIEW project on CD-Rom medium.

Survey Results. Figure 1.3-1 shows the location of the REMOTS survey stations south of the YP Pier in northeastern Derecktor Shipyard/Coddington Cove. From this imagery, several representative classes of habitat were observed, including 1) deep camera prism penetration showing both the absence of infauna and apparent sediment oxygen demand below the surface (Figure 1.3-1a), 2) shell lag at the surface (Figure 1.3-1b), and 3) pebble layer and macroalgae. Careful review of the images did not detect obvious evidence of man-made debris within the sediment of the surveyed area.

1.4. Derecktor Shipyard/Coddington Cove laser line scan characterization study.

The laser line scan (LLS) tow body system was designed to provide seafloor images with high coverage rates (Rhoads et al. 1997). The swath of the imaged area along a transect is approximately 1.4 times the altitude above the seafloor, affording image resolution in cm to mm range. Comparable image quality is obtained at a viewing range which is 5X conventional video.

Survey Methods. Survey operations were performed on 21 and 22 February 1998. The LLS system is composed of an underwater optical sensor consisting of solid stat ND-YAG (blue-green) laser with two 4-faceted rotating mirrors and a synchronized receiver. The topside control console provides control of LLS power requirements, data management and display, scan rate and aperture position. The LLS data are recorded in digital form on hard disc or as live video on stored cassette. A hydrodynamic tow body including umbilical cable and power supply completes the hardware configuration.

Data Processing. Image data collected from the LLS system is digitized using RasterOps video capture hardware. Video images of each survey line are stored in series of standard image files, with real time correction of the image for heading, speed, and slant range. As a result, the video image can be considered as a continuous mosaic of pixels in rectified spatial geometry. ARCVIEW software is used to transfer the image data and associated marker files into GIS format for distribution on CD-ROM medium.

Survey Results. Figure 1.4-1a shows the boundaries of the LLS survey in Derecktor Shipyard/Coddington Cove. From this imagery, various objects were observed, locations for example images discussed below are shown in Figure 1.4-1b. These images include 1) bottom debris with rope and/or cable attached (Figure 1.4-2a), 2) rope/cable coiled on the sediment (Figure 1.4-2b), and 3) a lobster pot (Figure 1.4-2c). A review of the images reveal a variety of debris types and locations as summarized in Table 1. All images can be viewed in the ARCVIEW project.

2.0. References

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Rhoads, D.C. and J.D. Germano. 1986. Interpreting long-term changes in benthic community structure: a new protocol. Hydrobiologia 142: 291-308.

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Valente, R.M., D.C. Rhoads, J.D. Germano, V.J. Cabelli. 1992. Mapping of benthic enrichment patterns in Narragansett Bay, Rhode Island. Esutaries 15(1): 1-17.

Figure 1.1-1. Survey areas for Derecktor Shipyard/Coddington Cove study area.

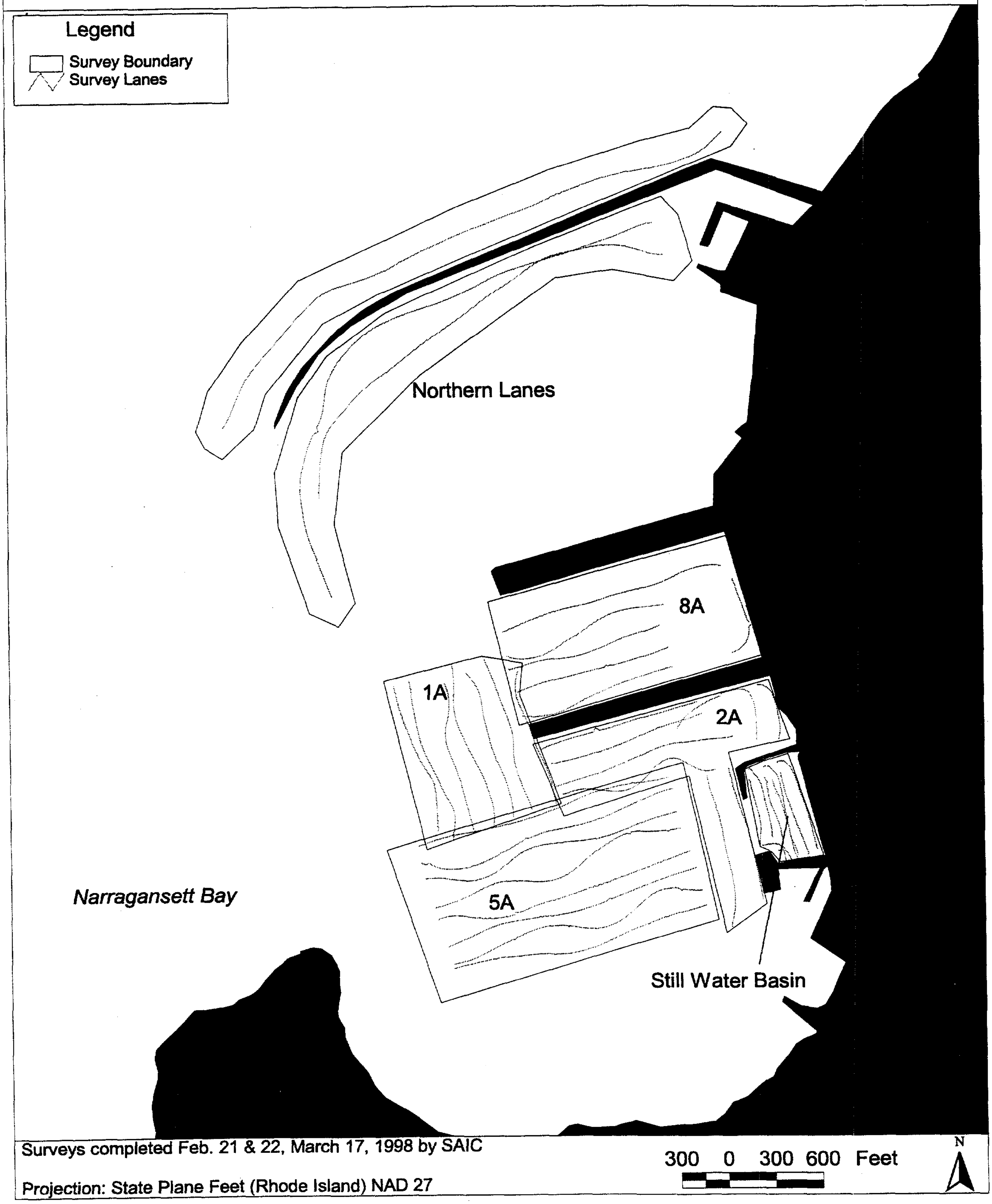
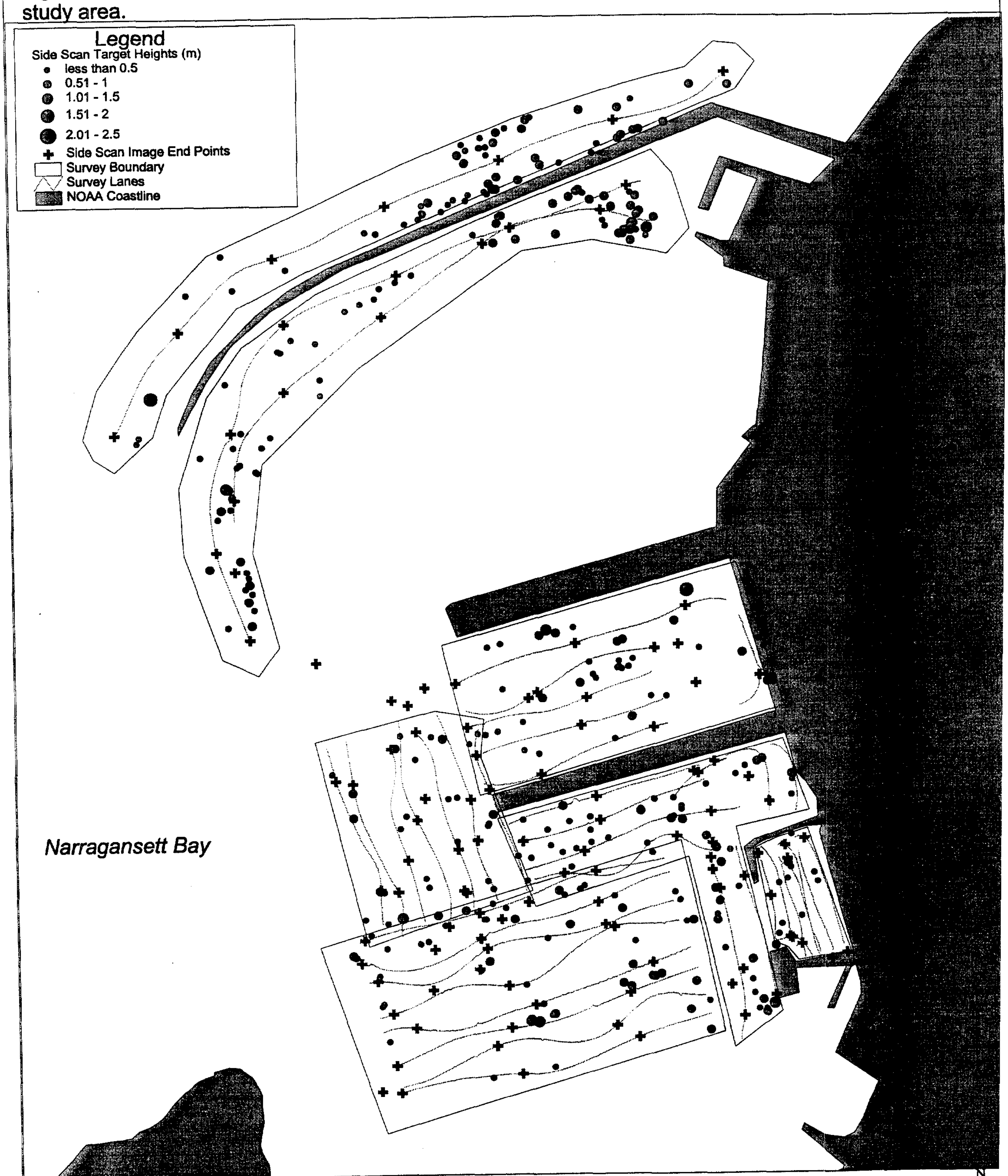


Figure 1.1-2. Side scan target locations and target heights off Derecktor Shipyard/Coddington Cove study area.



Side Scan Sonar survey completed Feb. 21 & 22, March 17, 1998 by SAIC

Projection: State Plane Feet (Rhode Island) NAD 27

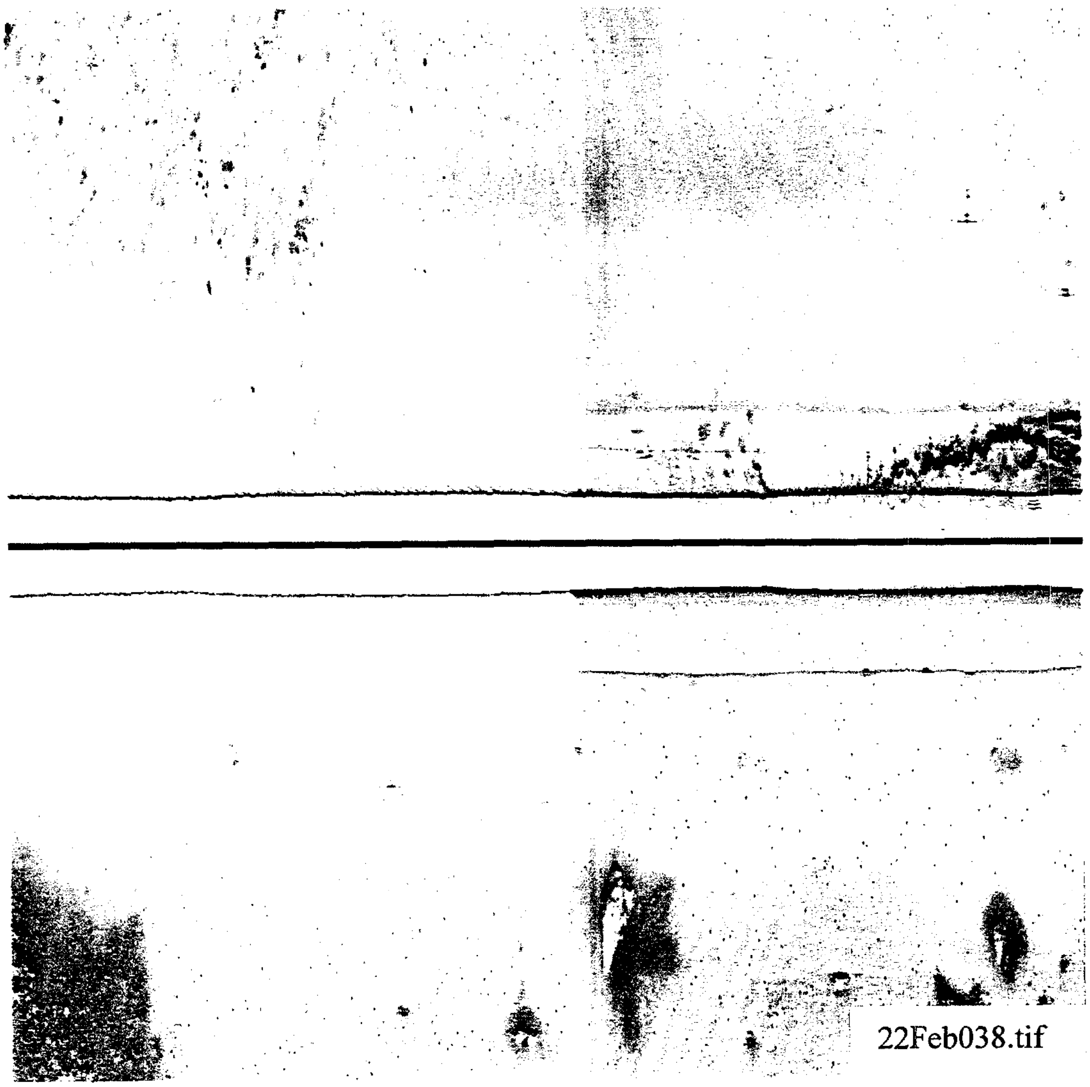


Figure 1.1-3a. Side scan sonar image showing rocky bottom in the Derecktor Shipyard/Coddington Cove study area.

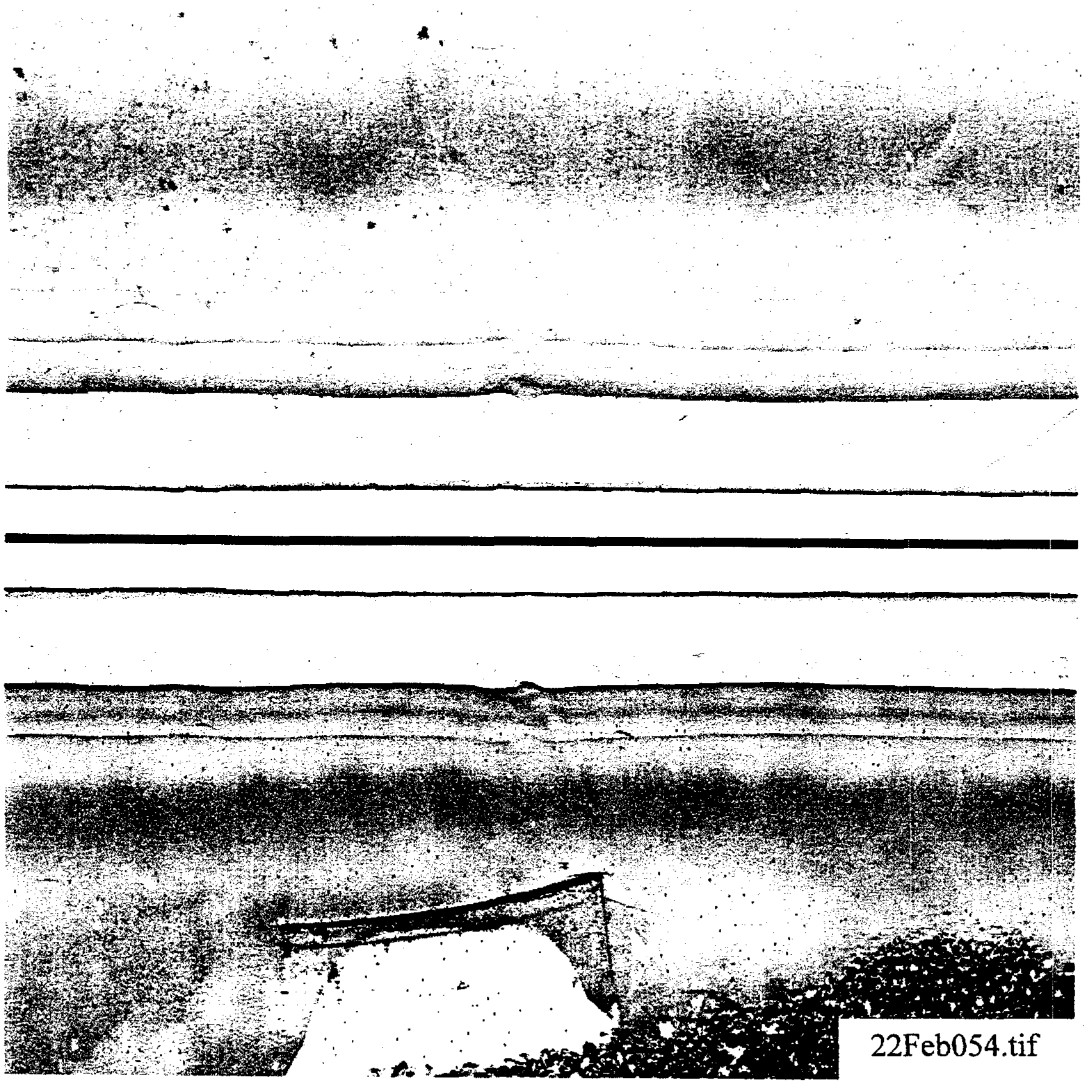
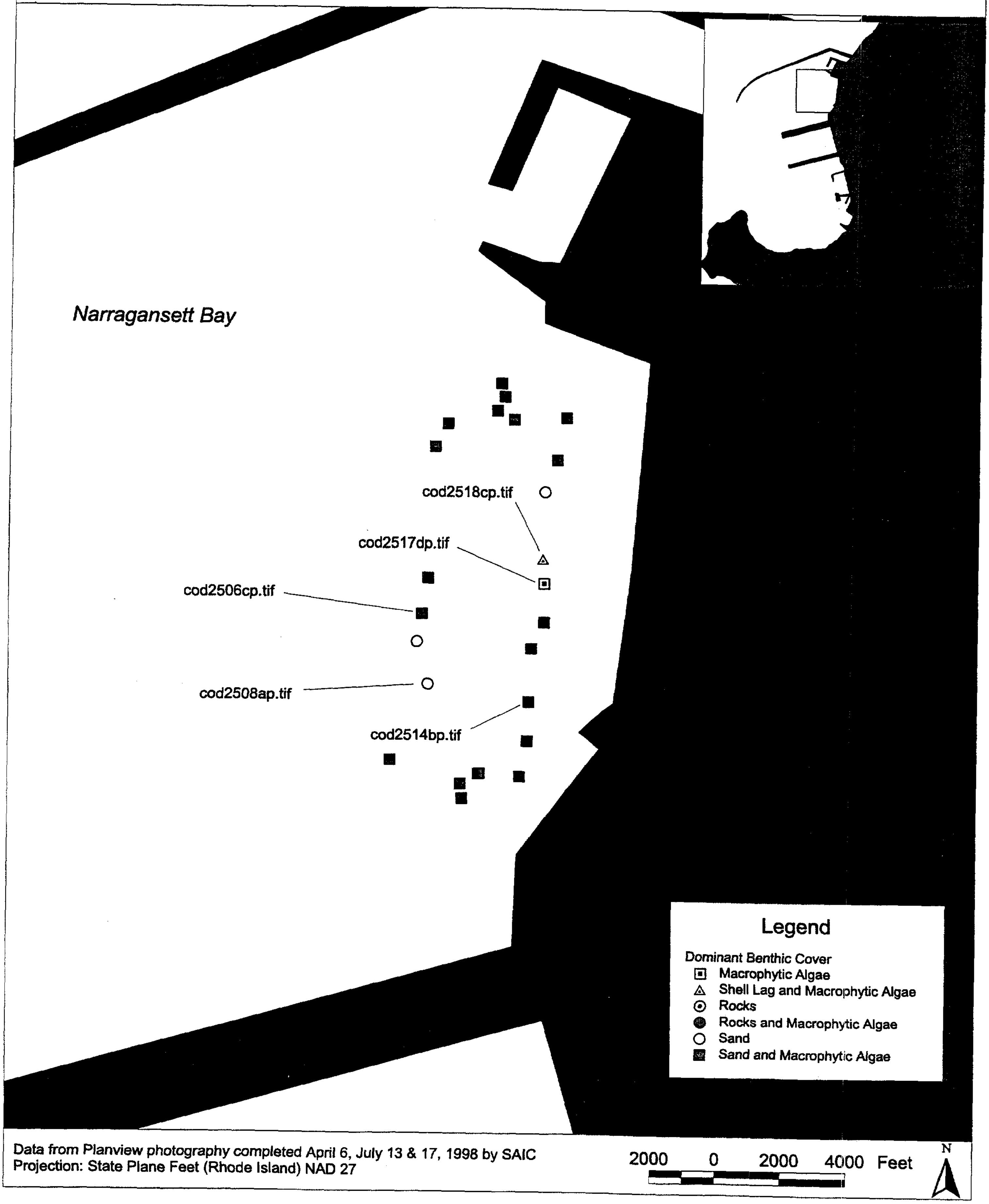


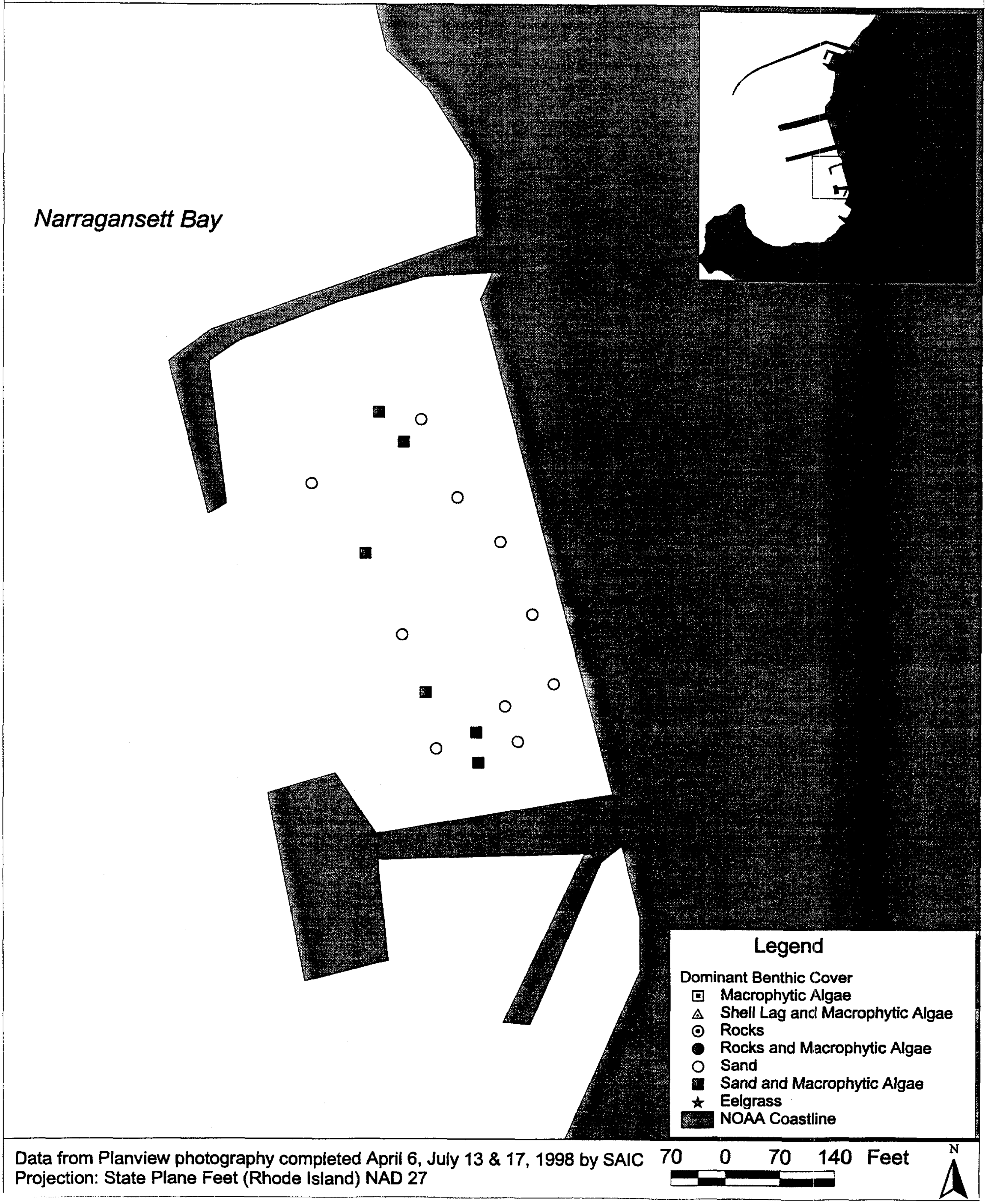
Figure 1.1-3b. Side scan sonar image showing man-made object in the Derecktor Shipyard/Coddington Cove study area.

Figure 1.2-1a. Photosea target locations and dominant benthic cover in the northeastern section of the Derecktor Shipyard/Coddington Cove study area.



Data from Planview photography completed April 6, July 13 & 17, 1998 by SAIC
Projection: State Plane Feet (Rhode Island) NAD 27

Figure 1.2-1b. Dominant benthic cover in the stillwater basin section of the Derecktor Shipyard/Coddington Cove study area.



Data from Planview photography completed April 6, July 13 & 17, 1998 by SAIC
Projection: State Plane Feet (Rhode Island) NAD 27

Figure1.2-2a. Planview photographic image of macrophytic algae in the Derecktor Shipyard/Coddington Cove study area.

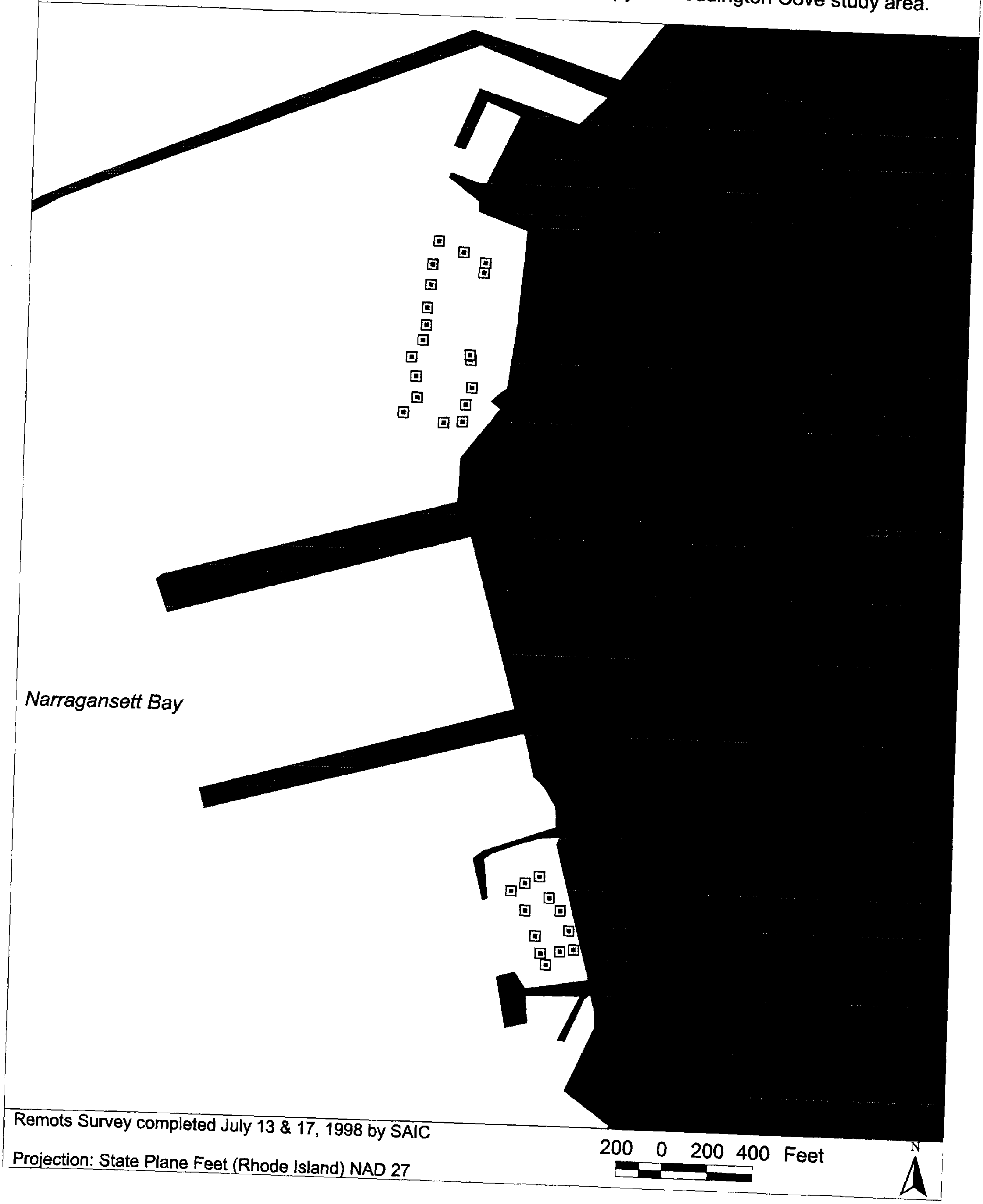
Figure1.2-2b. Planview photographic image of shells and macrophytic algae in the Derecktor Shipyard/Coddington Cove study area.

Figure1.2-2c. Planview photographic image of sand, macrophytic algae, and a blue crab in the Derecktor Shipyard/Coddington Cove study area.

Figure1.2-2d. Planview photographic image of sand and macrophytic algae in the Derecktor Shipyard/Coddington Cove study area.

Figure1.2-2e. Planview photographic image of a sand bottom in the Derecktor Shipyard/Coddington Cove study area.

Figure 1.3-1. REMOTS survey stations off the Derecktor Shipyard/Coddington Cove study area.



Remots Survey completed July 13 & 17, 1998 by SAIC

Projection: State Plane Feet (Rhode Island) NAD 27

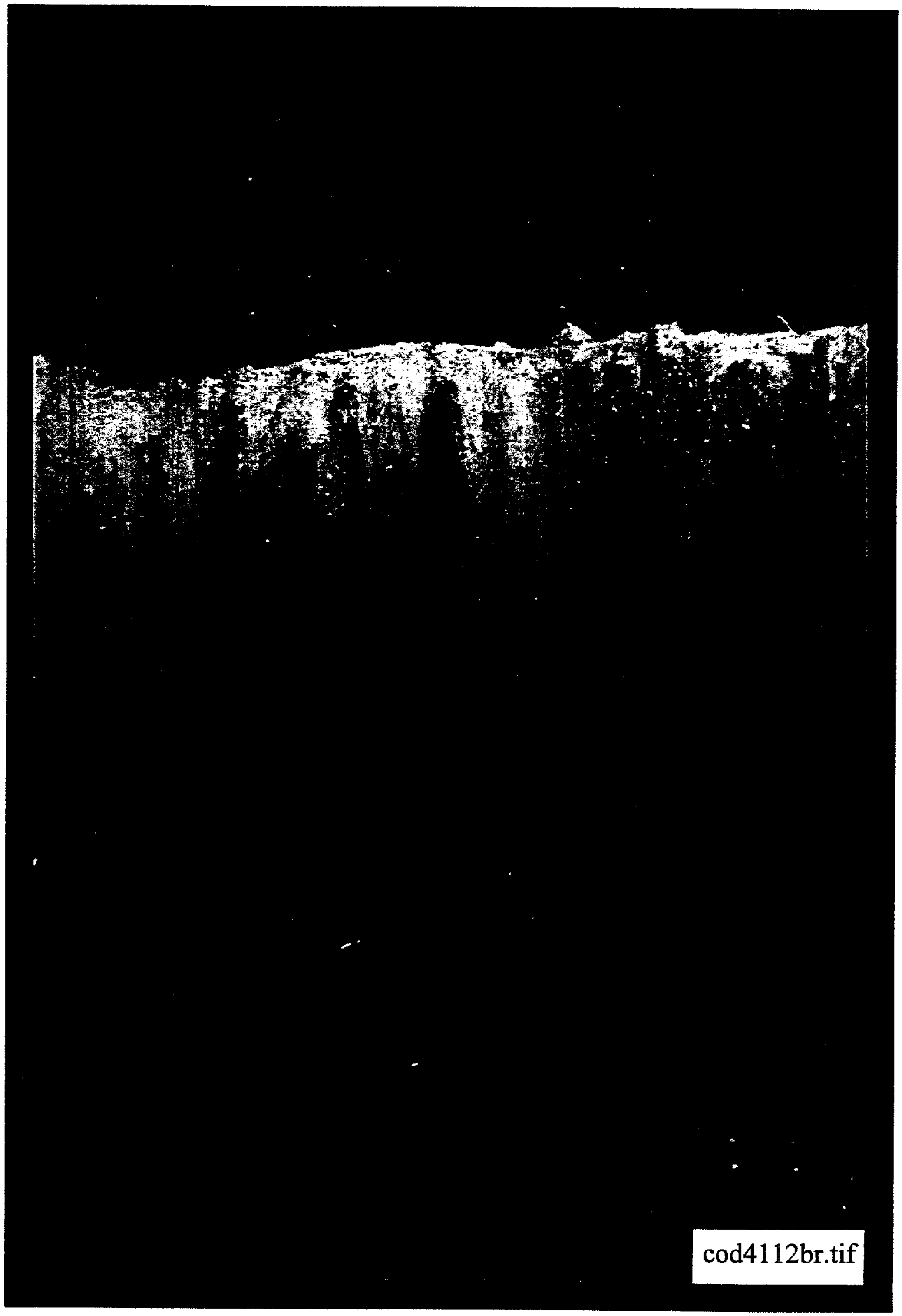


Figure 1.3-1a. Sediment-profile image representing both the absence of infauna and high apparent sediment oxygen demand in the Derecktor Shipyard/Coddington Cove study area.

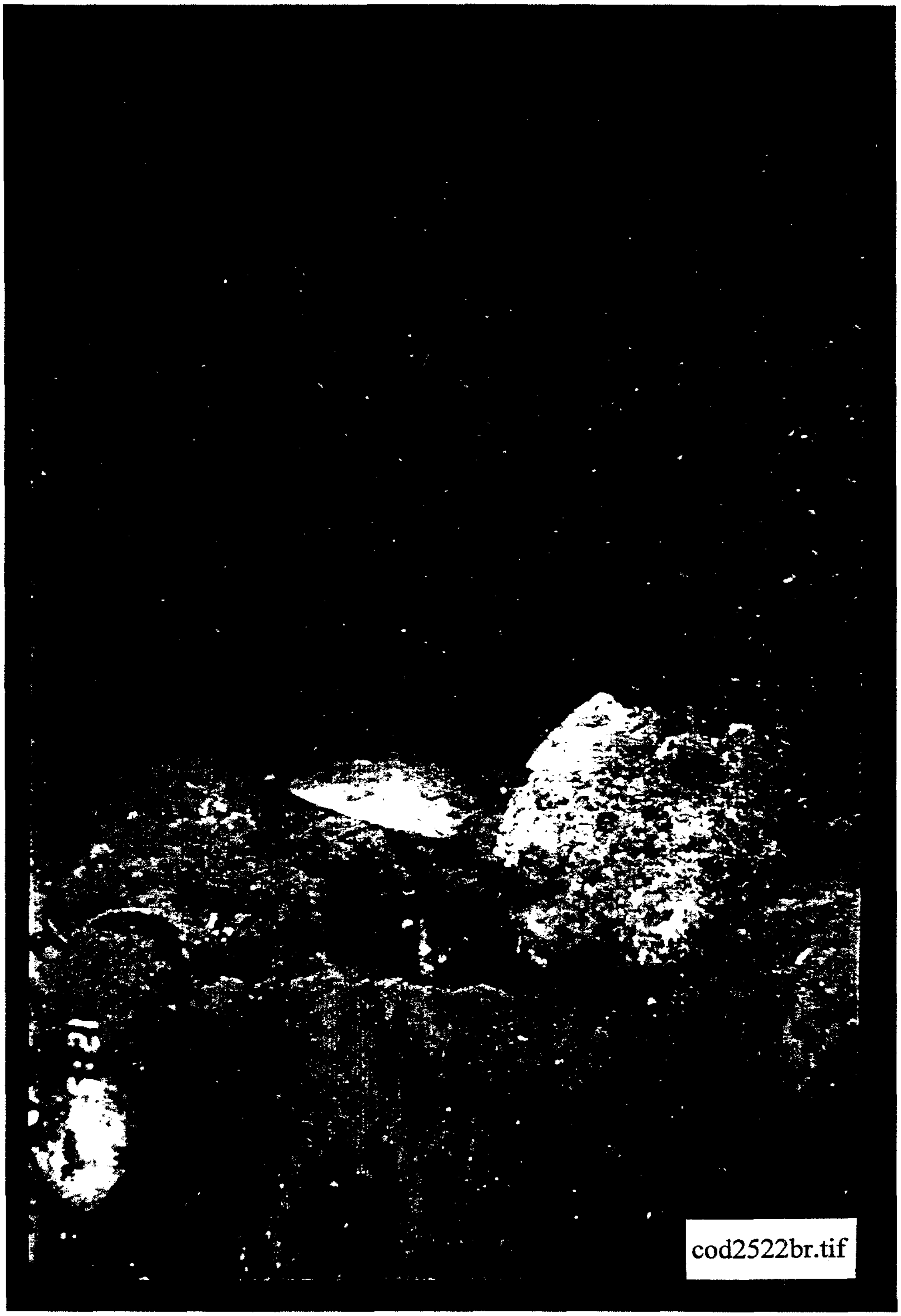


Figure 1.3-1b. Sediment-profile image representing shell lag on surface sediment in the Derecktor Shipyard/Coddington Cove study area.

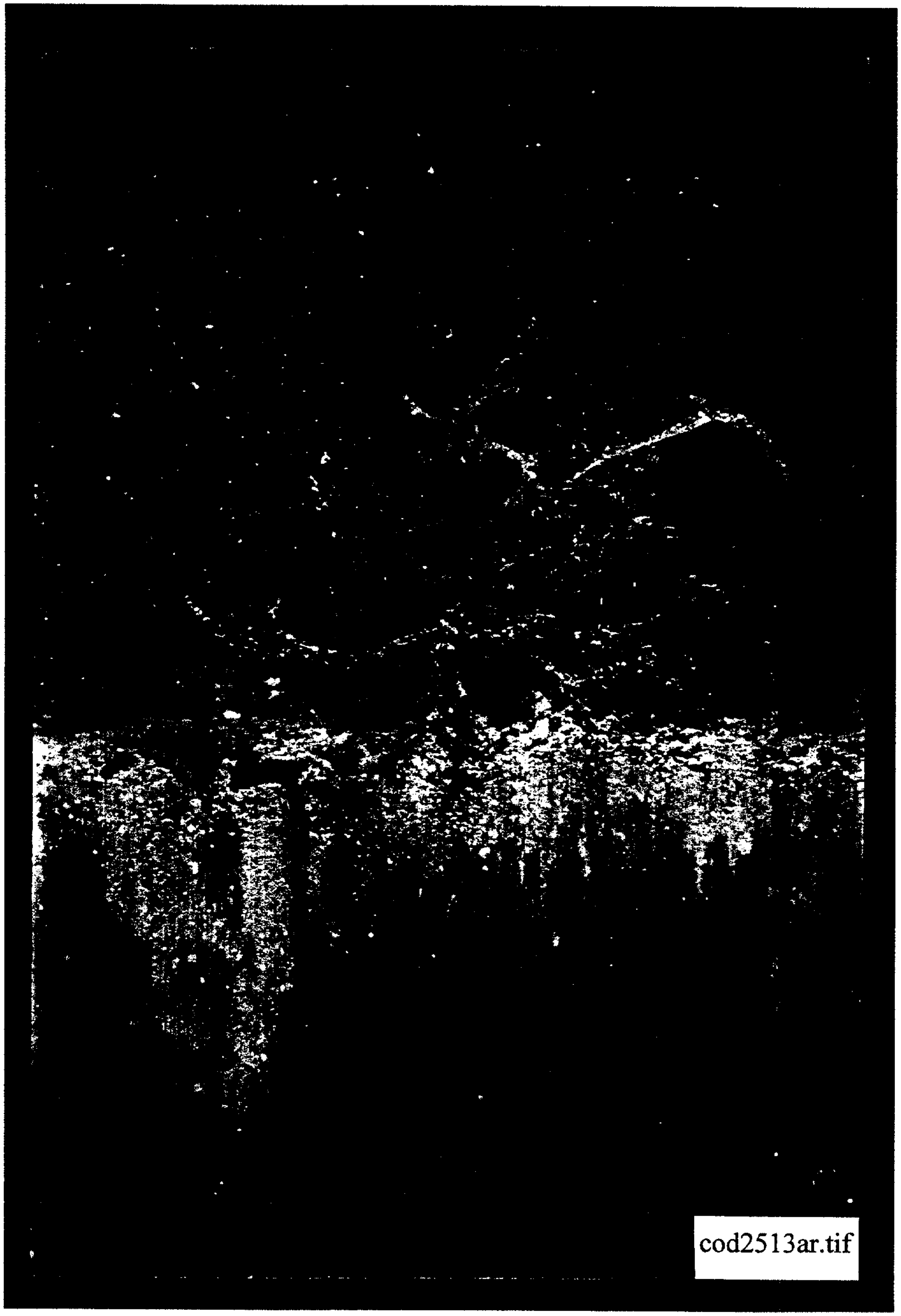


Figure 1.3-1c. Sediment-profile image representing a pebble layer and macroalgae on surface sediment in the Derecktor Shipyard/Coddington Cove study area.

Figure 1.4-1a. Laser line scan survey areas and target locations off Derecktor Shipyard/Coddington Cove study area.

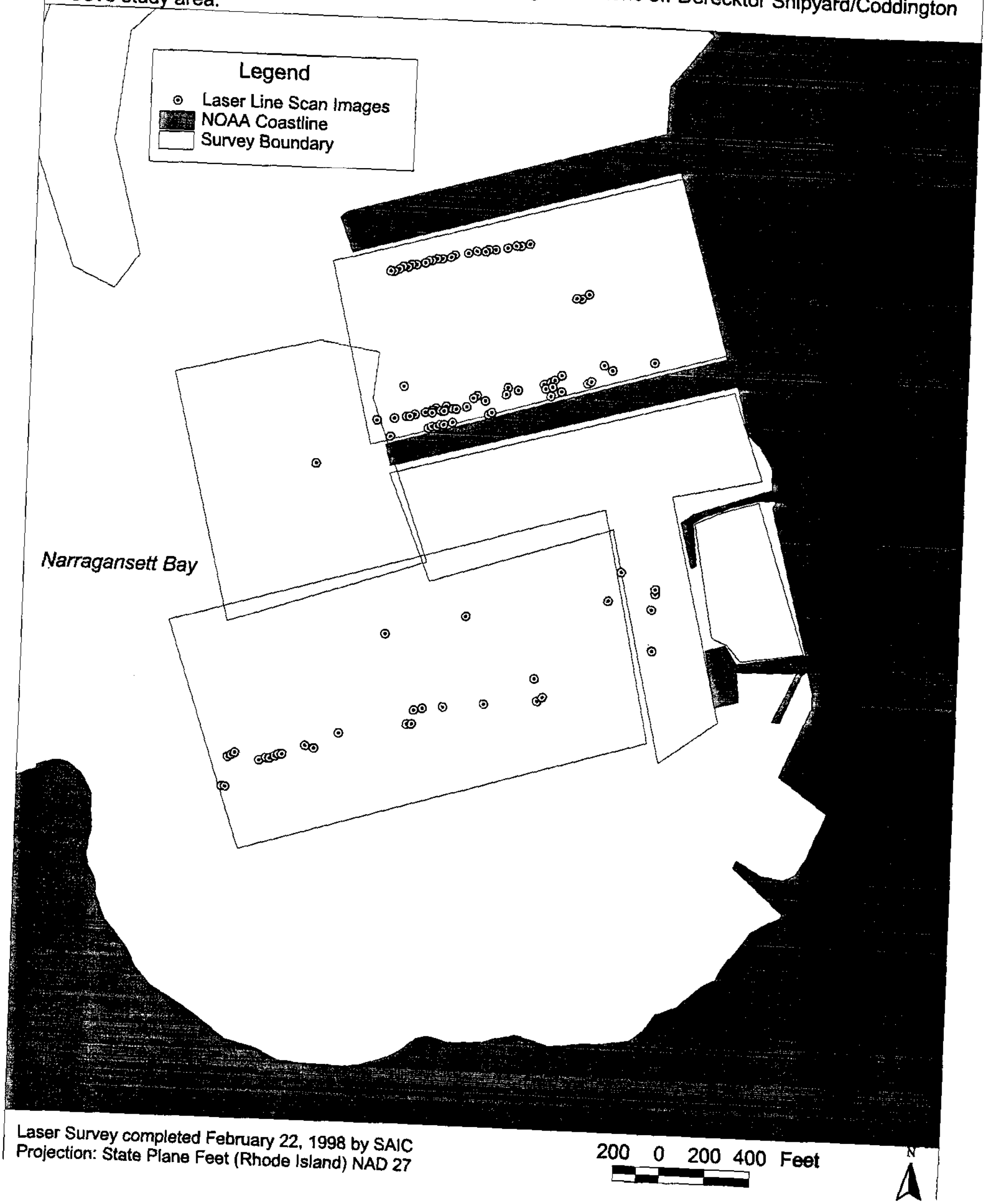
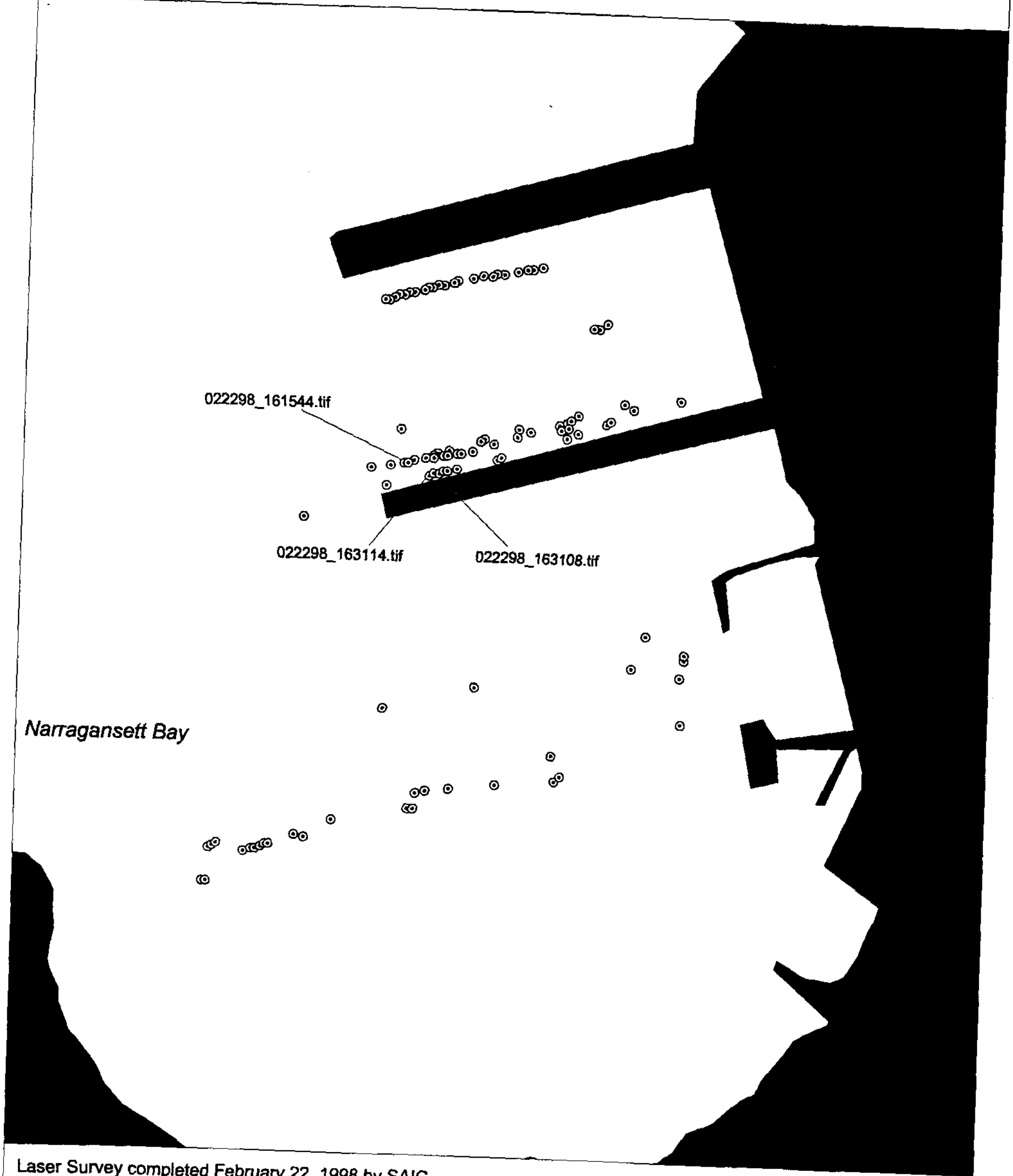


Figure 1.4-1b. Locations of laser line scan target locations off Derecktor Shipyard/Coddington Cove study area.



Laser Survey completed February 22, 1998 by SAIC
Projection: State Plane Feet (Rhode Island) NAD 27

100 0 100 200 300 Feet

N

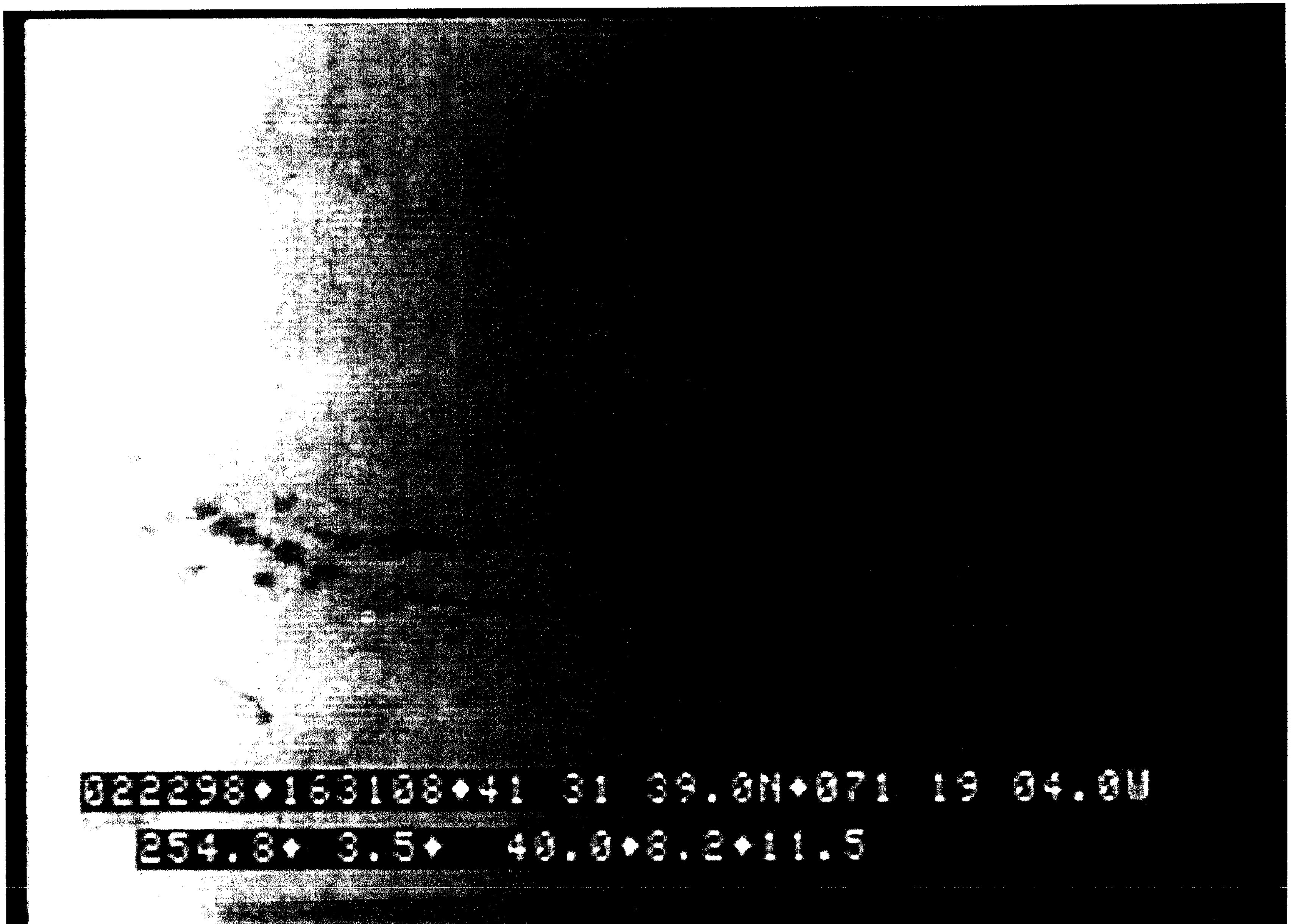


Figure 1.4-2a. Laser line scan survey image of bottom debris with attached rope and/or cable in the Derecktor Shipyard/Coddington Cove study area.

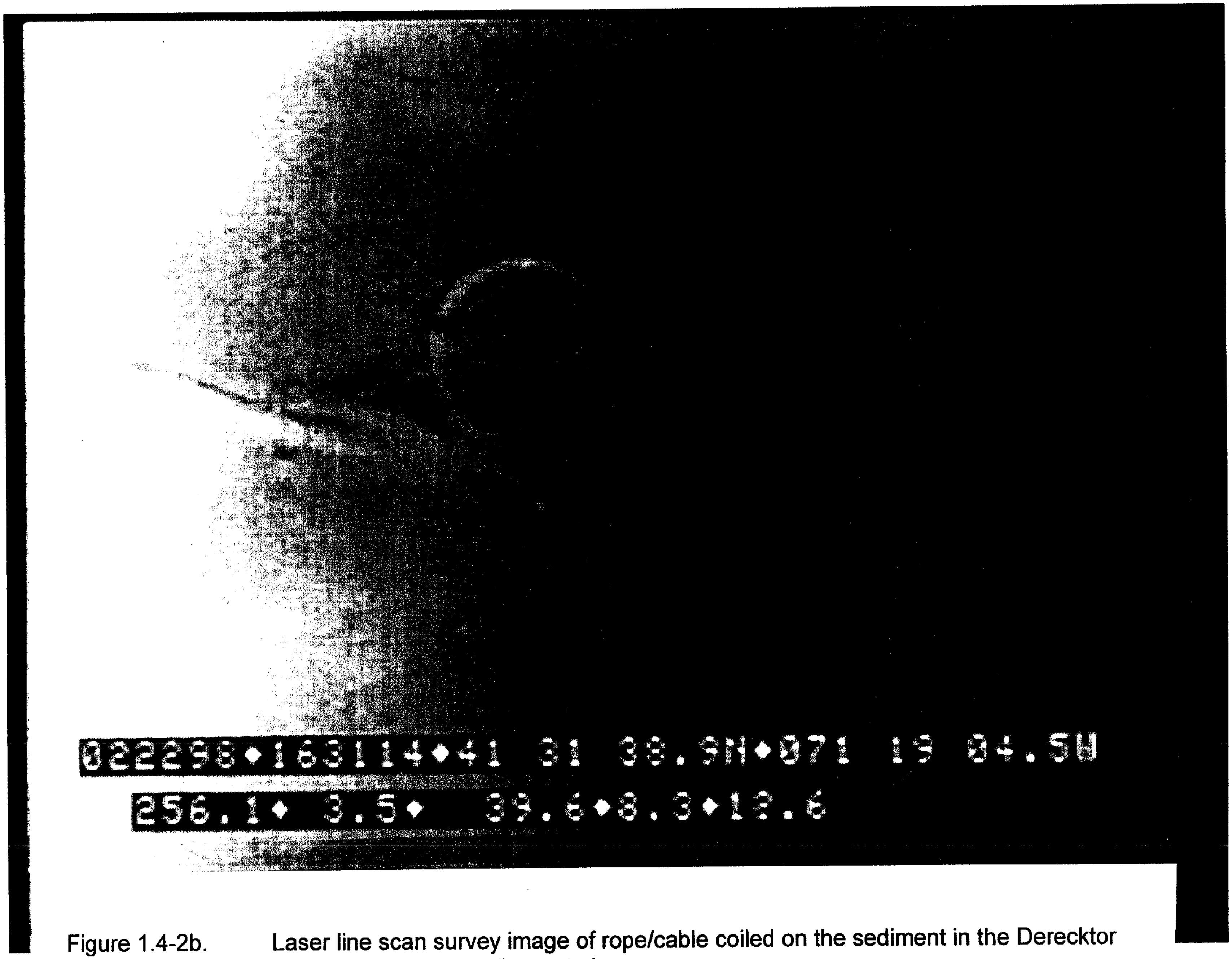


Figure 1.4-2b. Laser line scan survey image of rope/cable coiled on the sediment in the Derecktor Shipyard/Coddington Cove study area.

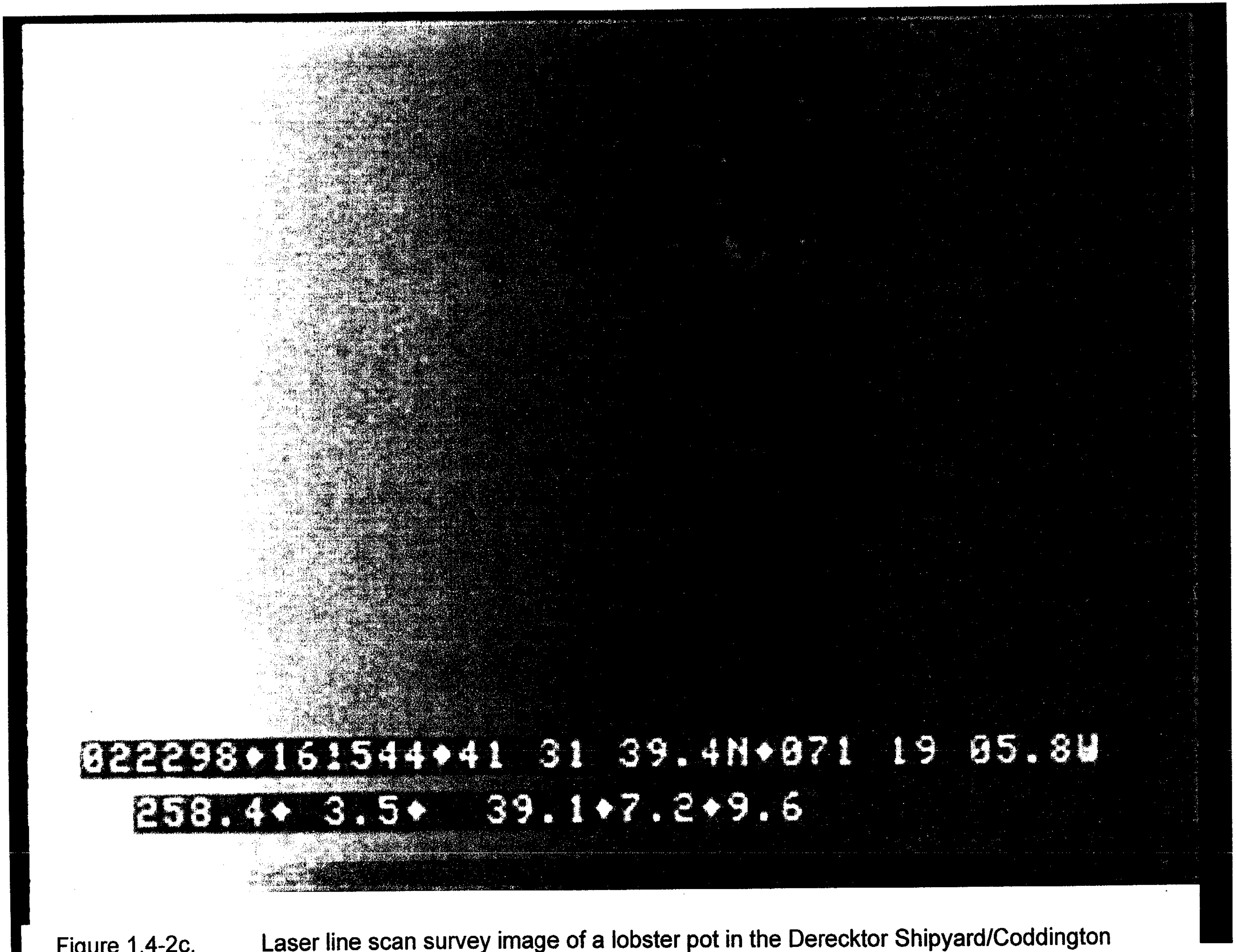


Figure 1.4-2c. Laser line scan survey image of a lobster pot in the Derecktor Shipyard/Coddington Cove study area.

Table 1. Laser Line Scan Survey image results of Derecktor Shipyard/Coddington Cove study area.

Station	Image Description	Station	Image Description
022198-204742	Misc Debris /Concrete Block	022298-151010b	Hard Bottom/Debris
022198-205423	Rock/Hard Bottom	022298-151014a	Misc Debris
022198-205442	Hard Bottom	022298-151014b	Sandy Bottom and pipe
022198-205455	Rocky Bottom	022298-151017	Soft Bottom/Debris
022198-205458	Rocky Bottom	022298-151023a	Debris
022198-205501	Rocky Bottom	022298-151023b	Log/Pipe
022198-205508	Hard Bottom	022298-151026	Ropes
022198-205520	Rocky Bottom	022298-151036	Sandy Bottom
022198-205523	Rocky Bottom; Rope	022298-151042	Sandy Bottom and Rock
022198-205539	Rocks and Macrophytic Algae	022298-151048	Sandy Bottom and Rock
022198-205644	Macrophytic Algae	022298-151051	Misc Debris, Rocks, and Algae
022198-205808	Sandy Bottom	022298-151055	Sandy Bottom and Rocks
022198-205833	Sandy Bottom/Logs or Pipe	022298-151104	Rocks and Macrophytic Algae
022198-211848	Sandy Bottom	022298-151110	Ropes
022198-211900	Rocks and Macrophytic Algae	022298-151113	Sandy Bottom
022198-211925	Rocks and Macrophytic Algae	022298-151120	Misc Debris, Rocks, and Algae
022198-211928	Rocks and Macrophytic Algae	022298-151653	Sandy Bottom
022198-211934	Rocks and Macrophytic Algae	022298-151659	Sandy Bottom and Rock
022198-211937	Rocks and Macrophytic Algae	022298-161235	Misc Debris
022198-212051	Rocks and Macrophytic Algae	022298-161308	Misc Debris (metal)
022198-212100	Rock with Macrophytic Algae	022298-161350a	Soft Bottom, Pipe
022198-212103	Hard Bottom	022298-161350b	Rocks and Macrophytic Algae
022198-212119	Rocks with Macrophytic Algae	022298-161353	Rocks and Macrophytic Algae
022198-212147	Rocks with Macrophytic Algae	022298-161359a	Sandy Bottom
022198-212157	Rocks with Macrophytic Algae	022298-161359b	Misc Debris
022198-214639	Rocks with Macrophytic Algae	022298-161418	Misc Debris
022198-214835	Soft Bottom	022298-161428	Sandy Bottom
022298-143147	Sandy Bottom/Debris	022298-161444	Sandy Bottom
022298-143151	Sandy Bottom	022298-161459	Ropes, Rocks and Algae
022298-143157	Sandy Bottom	022298-161506	Rocks and Macrophytic Algae
022298-143633	Sandy Bottom	022298-161509	Soft Bottom/Pipe
022298-150939	Misc Debris	022298-161515	Soft Bottom/Pipe
022298-150942	Misc Debris	022298-161518	Soft Bottom/Pipe
022298-150945	Sandy Bottom	022298-161525	Misc debris
022298-150948	Sandy Bottom	022298-161541	Sandy Bottom and Rocks
022298-150952	Sandy Bottom	022298-161544	Lobster Pot*
022298-150955a	Sandy Bottom	022298-161553	Misc debris
022298-150955b	Sandy Bottom and pipe	022298-161606	Sandy Bottom and Rock
022298-150958	Sandy Bottom and pipe	022298-162111	Ropes
022298-151004	Sandy Bottom	022298-162118	Ropes
022298-151007a	Rope	022298-162124	Sandy Bottom
022298-151007b	Sandy Bottom	022298-162127	Sandy Bottom
022298-151010a	Sandy Bottom/Debris	022298-162134	Wires/Rope

* Image provided as Figure (see Figures 1.4-2a, 1.4-2b, and 1.4-2c).

Table 1 (continued). Laser Line Scan Survey image results of Derecktor Shipyard/Coddington Cove study area.

Station	Image Description	Station	Image Description
022298-162156	Sandy Bottom and Rock	022298-194710	Sandy Bottom
022298-162159	Sandy Bottom	022298-194726	Sandy Bottom
022298-162224	Rope	022298-194732	Sandy Bottom
022298-162305	Ropes and Misc debris	022298-194834	Misc Debris
022298-162337	Pipe	022298-194903	Misc Debris
022298-162846	Sandy Bottom	022298-194922a	Rope
022298-162905	Rocks with Macrophytic Algae	022298-194922b	Misc Debris
022298-162908	Bricks	022298-194925	Rope
022298-162930	Rocks with Macrophytic Algae	022298-194928	Rocks and Macrophytic Algae
022298-162937	Sandy Bottom	022298-194932	Misc Debris
022298-163024	Sandy Bottom	022298-194935	Ropes
022298-163027	Lobster Pot	022298-194941	Hard Bottom
022298-163055	Misc debris		
022298-163102	Rope and Macrophytic algae		
022298-163105a	Misc debris		
022298-163105b	Sandy Bottom and Rock		
022298-163108	Lobster Pot*		
022298-163111	Misc debris		
022298-163114	Ropes*		
022298-163143	Misc Debris (metal)		
022298-163246	Soft Bottom/Algae		
022298-191217	Sandy Bottom/Debris		
022298-191223a	Sandy Bottom		
022298-191223b	Lobster Pot		
022298-191236a	Sandy Bottom		
022298-191236b	Misc Debris (metal)		
022298-191311	Sandy Bottom		
022298-191529	Sandy Bottom		
022298-191536	Sandy Bottom		
022298-191720	Misc Debris		
022298-191724	Sandy Bottom		
022298-191842	Misc Debris		
022298-192003	Misc Debris		
022298-192006	Wire		
022298-192432	Sandy Bottom		
022298-192533	Sandy Bottom		
022298-192730	Sandy Bottom		
022298-193056	Misc Debris		
022298-193504	Sandy Bottom		
022298-193507	Ropes		
022298-193511	Sandy Bottom		
022298-194640	Misc Debris		

* Image provided as Figure (see Figures 1.4-2a, 1.4-2b, and 1.4-2c).

APPENDIX C
CHARACTERIZATION OF BENTHIC COLONIZATION POTENTIAL, DERECKTOR SHIPYARD/CODDINGTON COVE STILLWATER BASIN. SAIC, NOVEMBER 9, 1998

DRAFT REPORT

CHARACTERIZATION OF BENTHIC COLONIZATION POTENTIAL IN THE DERECKTOR SHIPYARD/CODDINGTON COVE STILLWATER BASIN

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1.0 INTRODUCTION

This report presents the results of a focussed environmental investigation of the Stillwater Basin southeast of Building 42 at Derecktor Shipyard. Although this area was characterized as a part of a cove-wide ecological risk assessment (SAIC and URI, 1997), additional investigations were performed in order to address questions from the Ecorisk Advisory Board (EAB) for NETC; specifically to address the lack of indigenous biota at two stations sampled in Stillwater Basin. The purpose of this report is present the results of a focussed environmental investigation of the Stillwater Basin southeast of Building 42 at Derecktor Shipyard. Although this area was characterized as a part of a cove-wide ecological risk assessment (SAIC and URI, 1997), additional investigations were performed in order to address questions from the ecorisk advisory board for NETC, specifically to address the general lack of indigenous biota in Stillwater Basin.

To support this investigation, the TTNUS directed SAIC to perform environmental characterization studies to assess the Stillwater Basin conditions and a nearby reference area. The purpose of the study was to characterize the biological, geological and physical conditions of the two study areas and by the comparison of findings, deduce the extent to which the Stillwater Basin habitat is degraded and elucidate possible contributing factors. Background information on Stillwater Basin (Section 1.1) leading to specific objectives of the study (Section 1.2) are presented below.

1.1 Background of the Stillwater Basin Investigation

The marine sediments of the stillwater basin were investigated as part of the Derecktor Shipyard Marine Ecological Risk Assessment Report (SAIC and URI May 1997). The findings of the ERA included results of sampling at two stations in the basin (DSY-40, DSY-41) with complete sediment chemistry, toxicity and benthic community characterization. Measurement of chemical exposure conditions in Stillwater Basin did not reveal CoC concentrations which would be expected to adversely impact aquatic biota, resulting in a conclusion of overall low exposure. However, the effects-based Weights of Evidence (WoE) led to the conclusion of overall intermediate effects, largely based on observed reduction in benthic community metrics (total number of individuals, species, diversity, evenness) relative to off-site reference locations. Another metric of possible adverse effects on the habitat included fecal pollution indicator concentrations in deployed mussels. (Fecal organisms, although not expected to directly affect biota, are assumed indicative of nutrient loading and resulting hypoxic stress which would degrade the habitat. Fecal indicators were found to be high in deployed mussels in stillwater basin and sediments sampled for benthic community were observed to have a shallow oxygen horizon (Redox Discontinuity Potential, RPD) indicating eutrophic conditions. Other effects-based measures including deployed mussel condition, toxicity and neoplasia (a blood cell disorder) did not suggest adverse effects on aquatic receptors. Given the conclusion of low exposure but intermediate effects for stations in Stillwater Basin, the ERA assigned the probability of risk as intermediate.

1.2. Objectives

Based on these observations, it was postulated that nutrient loading and resulting hypoxic conditions may be responsible for degraded benthic community structure observed at the two stations in the basin. Hence, the objective of this investigation was to conduct a more detailed evaluation of the benthic environment so as to confirm, and if possible, determine the cause of azoic conditions. Specific hypotheses addressed by the investigation and associated approach are as follows:

Hypotheses:

Ho: Environmental quality of the water column in Stillwater Basin is sufficient to support the development of a balanced infaunal and epifaunal community.

Approach:

Benthic colonization studies were conducted thru collection and analysis of epifaunal settlement on artificial substrates placed within Stillwater Basin and in a nearby reference area. At each area, two deployment locations were maintained. At each of the locations, duplicate substrates were placed in direct contact with the sediment and in the water column immediately (0.5 m) above the sediment. Substrates were deployed during spring, early summer and late summer to assess effects of seasonality with respect to organisms available for colonization. Discrete and continuous (summer only) measurements of water column dissolved oxygen were collected in conjunction with the deployments. A consistent trend of reduced community metrics in Stillwater Basin site relative to the reference area would result in rejection of the hypothesis and acceptance of the alternate hypothesis that reduced water quality in Stillwater Basin does contribute to a lack of benthic colonization in this area.

Ho: Sediment quality in Stillwater Basin is sufficient to support the development of a balanced indigenous community.

Approach:

Habitat quality studies were conducted by collection and analysis of surficial (planform) and interfacial (REMOTS) sediment photographs at locations throughout the Stillwater Basin and reference areas. At each location, the dominant form of benthic cover in planform photographs was characterized and delineated into 7 classifications: (1) Macrophytic algae, 2) Shell lag and macrophytic algae, 3) rocks, 4) rocks and macrophytic algae, 5) sand, 6) sand and macrophytic algae and 7) eelgrass. At the same locations, interfacial photographs were taken and characterized with respect to apparent grain size, RPD depth, and community successional stage (discussed in detail, in Section 2). Characterizations were conducted during mid-summer conditions when differences between areas were expected to be maximal. A general trend of reduced habitat quality in Stillwater Basin site relative to the reference area would result in rejection of the hypothesis and acceptance of the alternate hypothesis that poor habitat quality in Stillwater Basin does contribute to a lack of benthic colonization in this area

2.0 METHODS

Methods for benthic colonization, planform photography, and REMOTS data collection and analysis are discussed in Sections 2.1, Section 2.2 and Section 2.3, respectively. A common element of all surveys is navigation methods used to determine location for all field activities, discussed below.

SAIC installed its Portable Integrated Navigation and Survey System (PINSS) on the support vessel to provide navigational support for the crew and to digitally store survey data. Vessel positioning at predetermined stations was accomplished using a Magnavox 4200D GPS positioning system interfaced to the PINSS. The PINSS utilized a Toshiba 3200DX personal computer to provide real-time navigation, as well as to collect position, depth, and time data for subsequent analyses. One to five-meter accuracy was achieved by applying a differential correction to the GPS signals from an FM modem receiving Differential Corrections Incorporated (DCI) premium service. For planform photgraphy and REMOTS survey, the vessel position was displayed on two monitors, one for the survey navigator and the second for the helmsman to aid in steering the vessel toward target station locations. In addition, a Hewlett Packard 7475A plotter tracked the vessel's position during survey operations, allowing the navigator to assess the vessel's location relative to target station locations. An HP Thinkjet printer generated a hard copy of position fixes. Each fix incorporated time of day, the vessel's position in Latitude and Longitude, UTM coordinates, signal quality, and station and replicate identification. All differential GPS navigation data were received, logged and displayed in the North American Datum 1983 (NAD 83) geographic coordinate system.

2.1. Benthic Colonization Studies

Hester Dende artificial substrates were used for benthic colonization studies. These substrates were selected as they are routinely used in aquatic monitoring programs and were readily available from commercial vendors. An individual Hester Dende sampler consists of a series of 10 wooden disks assembled on a stainless steel spindle with a gradation of spacing between the disks from about 0.05 to 2.5 cm. At each deployment station, one pair of HD samplers were attached to a concrete block such that they were suspended approximately 0.5 mab (meters above bottom). For early and later summer deployments and additional pair was attached to the same block such that the samplers would lay on or slightly above the sediment surface(designated 0.05 mab). Two concrete blocks with HD arrays were placed within each of the Stillwater Basin and nearby reference areas. Concrete blocks consisting of the four HD samplers were marked and retrieved via a surface float attached to a retieval line. Upon retrieval to about 0.5 m of the surface, the samplers were carefully transferred to collection jars so as to prevent loss of organisms. Samplers were preserved in 10% formalin for 5-7 days then transferred to alcohol for shipment to the laboratory. The duration of deployment for spring (3/17-5/17/98), early summer (5/21-7/2/98) and late summer (7/20-8/31/98) was 45-60 days.

Discrete and continuous (summer only) measurements of water column dissolved oxygen were collected in conjunction with the deployments. Discrete water samples were collected with a 2L Niskin bottle and processed for dissolved oxygen concentration by Winkler titration. For the late summer colonization study, one Endeco Dissolved Oxygen recorder was deployed in each area and programmed to record temperature, salinity and DO data at 5 min intervals. Instruments were serviced (data retrieved, membranes replaced, and sensor recalibrated) at two week intervals during the deployment.

Benthic organisms settled on Hester Dende plates were scraped off and sieved at 0.5 mm. Species were identified to genus and species. The colonial ascidian, *Botryllus schlosseri*, was identified in all samples but could not be enumerated on an individual basis.

2.2. Planform Photography

2.2.1 Planform Photograph Acquisition

Planform photographs are horizontal plane pictures of the seafloor surface covering approximately 0.3 m^2 in area. Planform photographs were acquired with a PhotoSea 1000a 35mm Underwater Camera System and a PhotoSea 1500s Strobe Light attached to the REMOTS® camera frame. The photographs were taken immediately prior to the landing of the frame, providing an undisturbed record of the sediments before penetration of the REMOTS® prism. Once the camera frame was lifted above the sediments, the PhotoSea camera system automatically cycled film and recharged the strobe in preparation for the next photograph. In this manner, a corresponding planform photograph was usually obtained for each REMOTS® image acquired.

2.2.2 Planform Photograph Analysis

Analysis of the planform images included screening all the replicates taken at the stations sampled. Poor water clarity and lack of contrast eliminated some of the images from further consideration. Of the remaining, a representative collection was made, which included one image from each set of station replicates successfully photographed. Habitat quality studies were conducted by collection and analysis of surficial (planform) and interfacial (REMOTS) sediment photographs at locations throughout the Stillwater Basin and reference areas. At each location, the dominant form of benthic cover in planform photographs was characterized and delineated into 7 classifications: (1) Macrophytic algae, 2) Shell lag and macrophytic algae, 3) rocks, 4) rocks and macrophytic algae, 5) sand, 6) sand and macrophytic algae and 7) eelgrass. Since the surface sediment descriptions were based on visual observations and therefore are somewhat subjective, the obvious presence of the feature was required for assignment to the category.

2.3 REMOTS® Sediment-Profile Imaging

2.3.1 REMOTS® Image Acquisition

REMOTS® is a formal and standardized technique for sediment-profile imaging and analysis (Rhoads and Germano 1982). A Benthos Model 3731 Sediment Profile Camera (Benthos, Inc., North Falmouth, MA) was used in this study. The camera is designed to obtain *in situ* profile images of the top 20 cm of sediment. Functioning like an inverted periscope, the camera consists of a wedge-shaped prism with a front face plate and a back mirror mounted at a 45-degree angle to reflect the profile of the sediment-water interface facing the camera. The prism is filled with distilled water, the assembly contains an internal strobe used to illuminate the images, and a 35-mm camera is mounted horizontally on top of the prism. The prism assembly is moved up and down into the sediments by producing tension or slack on the winch wire. Tension on the wire keeps the prism in the up position, out of the sediments.

The camera frame is lowered to the seafloor at a rate of about 1 m/sec. When the frame settles onto the bottom, slack on the winch wire allows the prism to penetrate the seafloor vertically. A passive hydraulic piston ensures that the prism enters the bottom slowly (approximately 6 cm/sec) and does not disturb the sediment-water interface. As the prism starts to penetrate the seafloor, a trigger activates a 13-second time delay on the shutter release to allow maximum penetration before a photo is taken. A Benthos Model 2216 Deep Sea Pinger is attached to the camera and outputs a constant 12 kHz signal of one ping per second; upon discharge of the camera strobe, the ping rate doubles for 10 seconds. Monitoring the signal output on deck provides confirmation that a successful image was obtained. Because the sediment photographed is directly against the face plate, turbidity of the ambient seawater does not affect image quality. When the camera is raised, a wiper blade cleans off the face plate, the film is advanced by a motor drive, the strobe is recharged, and the camera can be lowered for another image.

For the present investigation, the REMOTS® camera was lowered multiple times at each station in an attempt to collect at least two replicate REMOTS® images and three corresponding planform photographs suitable for subsequent analysis. Color slide film was used and developed at the end of each field day to verify proper equipment operation and image acquisition.

2.3.2. REMOTS® Image Analysis

All replicate REMOTS® images were analyzed with a full-color computer image analysis system. The SAIC Image Analysis system uses a PC-based system integrated with a Javelin CCTV video camera and frame grabber. Color slides are digitally recorded as color images on computer disk. The image analysis software is a menu-driven program that incorporates user commands via keyboard and mouse. The system displays each color slide on the CRT while measurements of physical and biological parameters are obtained. Proprietary SAIC software allows the measurement and storage of data on up to 21 different variables for each REMOTS® image obtained. Automatic disk storage of all measured parameters allows data from any variables of interest to be compiled, sorted, displayed graphically, contoured, or compared statistically. All measurements were printed out on data sheets for a quality assurance check by SAIC Senior Scientist Dr. Donald Rhoads, one of the inventors of REMOTS® technology, before being approved for final data synthesis, statistical analyses, and interpretation. A summary of the major categories of REMOTS® data is presented below.

Optical Prism Penetration Depth. The optical prism penetrates the bottom under a static driving force imparted by the weight of the descending optical prism, camera housing, supporting mechanism, and weight packs. The penetration depth into the bottom depends on the force exerted by the optical prism and the bearing strength of the sediment. If the weight of the camera prism is held constant, the change in penetration depth over a surveyed site will reflect changes in geotechnical properties of the bottom. In this sense, the camera prism acts as a static-load penetrometer. The depth of penetration of the optical prism into the bottom can be a useful parameter, because dredged and capped materials often will have different shear strengths and bearing capacities.

Sediment Grain Size Distribution. The sediment grain size major mode and range are estimated visually from the photographs by overlaying a grain size comparator which is at the same scale. This comparator was prepared by photographing a series of Udden-Wentworth size classes (equal to or less than coarse silt up to granule and larger sizes) through the REMOTS® camera. Seven grain size classes are on this comparator: >4 phi, 4-3 phi, 3-2 phi, 2-1 phi, 1-0 phi, 0-(-1 phi), and <-1 phi. The lower limit of optical resolution of the photographic system is about 62 microns (4 phi), allowing recognition of grain sizes equal to or greater than coarse silt. The accuracy of this method has been documented by comparing REMOTS® estimates with grain size statistics determined from laboratory sieve analyses.

The major modal grain size that is assigned to an image is the dominant grain size as estimated by area within the imaged sediment column. In those images that show layering of sand and mud, the dominant major mode assigned to a replicate therefore depends on how much area of the photograph is represented by sand versus mud. These textural assignments may or may not correspond to traditional sieve analyses depending on how closely the vertical sampling intervals are matched between the grab or core sample and the depth of the imaged sediment.

Apparent Redox Potential Discontinuity (RPD) Depth. Aerobic near-surface marine sediments typically have higher reflectance values relative to underlying anoxic sediments. Sand also has higher optical reflectance than mud. These differences in optical reflectance are readily apparent in REMOTS® images; the oxidized surface sediment contains particles coated with ferric hydroxide (an olive color when associated with particles), while reduced and muddy sediments below this oxygenated layer are darker, generally grey to black. The boundary between the colored ferric hydroxide surface sediment and underlying grey to black sediment is called the apparent redox potential discontinuity (RPD).

The depth of the apparent RPD in the sediment column is an important time-integrator of dissolved oxygen conditions within sediment pore waters. In the absence of bioturbating organisms, this high reflectance layer (in muds) will typically reach a thickness of 2 mm (Rhoads 1974). This depth is related to the supply rate of molecular oxygen by diffusion into the bottom and the consumption of that oxygen by the sediment and associated microflora. In sediments that have very high sediment-oxygen demand, the sediment may lack a high reflectance layer even when the overlying water column is aerobic.

In the presence of bioturbating macrofauna, the thickness of the high reflectance layer may be several centimeters. The relationship between the thickness of this high reflectance layer and the presence or absence of free molecular oxygen in the associated pore waters must be made with caution. The boundary (or horizon) which separates the positive Eh region (oxidized) from the underlying negative Eh region (reduced) can only be determined accurately with microelectrodes. For this reason, we describe the optical reflectance boundary, as imaged, as the "apparent" RPD, and it is mapped as a mean value.

The depression of the apparent RPD within the sediment is relatively slow in organic-rich muds (on the order of 200 to 300 micrometers per day); therefore, this parameter has a long time constant (Germano and Rhoads 1984). The rebound in the apparent RPD is also slow (Germano 1983). Measurable changes in the apparent RPD depth using the REMOTS® optical technique can be detected over periods of one or two months. This parameter is used effectively to document changes (or gradients) which develop over a seasonal or yearly cycle related to water temperature effects on bioturbation rates, seasonal hypoxia, sediment oxygen demand, and infaunal recruitment.

The depth of the mean apparent RPD also can be affected by local erosion caused by current and/or wave scour. This can result in washing away of fines, development of shell or gravel lag deposits, and very thin apparent RPD depths. During storm periods, erosion may completely remove any evidence of the apparent RPD for dredged material disposal mounds (Fredette et al. 1988).

Another important characteristic of the apparent RPD is the contrast in reflectance values at this boundary. This contrast is related to the interactions among the degree of organic-loading, bioturbational activity in the sediment, and the levels of bottom-water dissolved oxygen in an area. High inputs of labile organic material increase sediment oxygen demand and, subsequently, sulfate reduction rates (and the abundance of sulfide end-products). This results in more highly reduced (lower reflectance) sediments at depth and higher RPD contrasts. In a region of generally low RPD contrasts, images with high RPD contrasts indicate localized sites of relatively high past inputs of organic-rich material (e.g., organic or phytoplankton detritus, dredged material, sewage sludge, etc.).

Sedimentary Methane. At extreme levels of organic-loading, pore-water sulphate is depleted, and methanogenesis occurs. The process of methanogenesis is detected by the appearance of methane bubbles in the sediment column. These gas-filled voids are readily discernible in REMOTS® images because of their irregular, generally circular aspect and glassy texture (due to the reflection of the strobe off the gas). If present, the number and total areal coverage of all methane pockets are measured.

Infaunal Successional Stages. The mapping of successional stages, as employed in this project, is based on the theory that organism-sediment interactions in fine-grained sediments follow a predictable sequence after a major seafloor perturbation (e.g., passage of a storm, disturbance by bottom trawlers, dredged material deposition, hypoxia). This theory states that primary succession results in "the predictable appearance of macrobenthic invertebrates belonging to specific functional types following a benthic disturbance. These invertebrates interact with sediment in specific ways. Because functional types are the biological units of interest, our definition does not demand a sequential appearance of particular invertebrate species or genera" (Rhoads and Boyer 1982). This theory is formally developed in Rhoads and Germano (1982; 1986) and Rhoads and Boyer (1982).

The term disturbance is used here to define natural processes, such as seafloor erosion, changes in seafloor chemistry, and foraging disturbances which cause major reorganization of the resident benthos; disturbance also includes anthropogenic impacts, such as dredged material or sewage sludge disposal, thermal effluent from power plants, bottom trawling, pollution impacts from industrial discharge, etc. An important aspect of using this successional approach to interpret benthic monitoring results is relating organism-sediment relationships to the dynamical aspects of end-member successional stages (i.e., Stage I, II, or III communities as defined in the following paragraphs). This involves deducing dynamics from structure, a technique pioneered by R. G. Johnson (1972) for marine soft-bottom habitats. The application of this approach to benthic monitoring requires *in situ* measurements of salient structural features of organism-sediment relationships as imaged through REMOTS® technology.

Pioneering assemblages (Stage I assemblages) usually consist of dense aggregations of near-surface living, tube-dwelling polychaetes; alternately, opportunistic bivalves may colonize in dense aggregations after a disturbance (Rhoads and Germano 1982, Santos and Simon 1980a). These functional types are usually associated with a shallow redox boundary; bioturbation depths are shallow, particularly in the earliest stages of colonization. In the absence of further disturbance, these early successional assemblages are eventually replaced by infaunal deposit feeders; the start of this "infaunalization" process is designated arbitrarily as Stage II. Typical Stage II species are shallow dwelling bivalves or, as is common in New England waters, tubicolous amphipods. In studies of hypoxia-induced benthic defaunation events in Tampa Bay, Florida, ampeliscid amphipods appeared as the second temporal dominant in two of the four recolonization cycles (Santos and Simon 1980a, 1980b).

Stage III taxa, in turn, represent high-order successional stages typically found in low-disturbance regimes. These invertebrates are infaunal, and many feed at depth in a head-down orientation. The localized feeding activity results in distinctive excavations called feeding voids. Diagnostic features of these feeding structures include a generally semicircular shape with a flat bottom and arched roof, and a distinct granulometric change in the sediment particles overlying the floor of the structure. This granulometric change is caused by the accumulation of coarse particles that are rejected by the animals feeding selectively on fine-grained material. Other subsurface structures, such as burrows or methane gas bubbles, do not exhibit these characteristics and therefore are quite distinguishable from these distinctive feeding structures.

The bioturbational activities of these deposit-feeders are responsible for aerating the sediment and causing the redox horizon to be located several centimeters below the sediment-water interface. In the retrograde transition of Stage III to Stage I, it is sometimes possible to recognize the presence of relict (i.e., collapsed and inactive) feeding voids. The end-member stages (Stages I and III) are easily recognized in REMOTS® images by the presence of dense assemblages of near-surface polychaetes and the presence of subsurface feeding voids, respectively; both types of assemblages may be present in the same image. Additional information on REMOTS® image interpretation can be found in Rhoads and Germano (1982, 1986).

Organism-Sediment Index (OSI). The multi-parameter REMOTS® Organism-Sediment Index (OSI) has been constructed to characterize habitat quality. Habitat quality is defined relative to two end-member standards. The lowest value is given to those bottoms which have low or no dissolved oxygen in the overlying bottom water, no apparent macrofaunal life, and methane gas present in the sediment (see Rhoads and Germano 1982, 1986, for REMOTS® criteria for these conditions). The OSI for such a condition is -10. At the other end of the scale, an aerobic bottom with a deeply depressed RPD, evidence of a mature macrofaunal assemblage, and no apparent methane gas bubbles at depth will have an OSI value of +11.

The OSI is a sum of the subset indices shown in Table 2-1. The OSI is calculated automatically by SAIC software after completion of all measurements from each REMOTS® photographic negative. The index has proven to be an excellent parameter for mapping disturbance gradients in an area and documenting ecosystem recovery after disturbance (Germano and Rhoads 1984, Revelas et al. 1987, Valente et al. 1992).

The OSI may be subject to seasonal changes because the mean apparent RPD depths vary as a result of temperature-controlled changes of bioturbation rates and sediment oxygen demand. Furthermore, the successional status of a station may change over the course of a season related to recruitment and mortality patterns or the disturbance history of the bottom. The sub-annual change in successional status is generally limited to Stage I (Polychaete-dominated) and Stage II (amphipod-dominated) seres. Stage III seres tend to be maintained over periods of several years unless they are eliminated by increasing organic loading, extended periods of hypoxia, or burial by thick layers of dredged material. The recovery of Stage III seres following abatement of such events may take several years (Rhoads and Germano 1982). Stations that have low OSI values (+6) are indicative of recently disturbed areas and tend to have greater temporal and spatial variation in benthic habitat quality than stations with higher OSI values (> +8).

3.0. RESULTS

3.1. Benthic Colonization Studies.

Ecological statistics for communities settled on artificial substrate deployed in the Derecktor Shipyard/Coddington Cove study area were calculated to evaluate potential water quality effects on benthic recruitment. Individual species counts by replicate are report in Table A1; summary ecological statistics for Hester Dende samplers deployed 0.5 mab and 0.05 mab are reported in

Table A-2 and Table A-3, respectively. The 0.5 mab deployments were conducted for each of the three time intervals (5/18; 7/2 and 8/31/98 retrievals); the 0.05 mab deployments were conducted for summer periods only (7/2 and 8/31/98). Statistics used to characterize the colonize community include: 1) total number of taxa, 2) total number of individuals, 3) Shannon-Wiener diversity, 4) Simpson's dominance, 5) species richness and 6) Pielou's evenness. These same statistics were used to characterize benthic community structure for the ERA investigation.

From review of raw data for 0.5 mab deployments (Table A2), generally good agreement was observed among replicates of a given station-metric pair with RPD values less than 30% were observed for the majority of within station statistical summaries. It is also noted that similarly good agreement was observed between the two stations in each of the study areas; 80% (29 of 36) of station pairs exhibited RPDs < 30%. There was also no apparent pattern of variation as a function of study area.

A similar review of raw data for 0.05 mab deployments (Table A3) also indicated generally good agreement among replicates; RPD values less than 30% were generally observed and worst-case variance was about two-fold (RPD ~ 50-60%). Again, similarly good agreement was observed between the two deployment locations in each of the study areas; the one exception was the Station DSY-26 data for the 8/31/98 retrieval which had generally reduced community metrics. Finally, there was also no apparent pattern of variation as a function of study area.

Summary statistics for the three deployments are summarized in Table 3.1-1 by area and distance above bottom of the samplers. In general, very good agreement was observed between areas for each statistic; 86% (26 of 30) of values had RPDs < 30% and 70% (21of 30) of values had RPDs < 15%. In the two cases where the between area RPD exceeded a factor of two (RPD = 50%), (total number of individuals, 0.05 mab, 7/2/98 and 8/31/98 retrievals) the trend would suggest improved water quality conditions within Stillwater Basin; higher abundance of individuals in absence of other metric indicator changes is generally viewed as a more balanced community condition. Hence, it is clear based on available data that no differences in benthic community colonization are apparent between Stillwater Basin and the reference area.

Environmental data collected during the deployment period are available and are presented in Figure 1 and Figure 2 for Reference and Stillwater Basin, respectively. Parameters include mean and maximum temperature, as well as mean and minimum salinity and dissolved oxygen concentration. For dissolved oxygen, a two-point moving average fit to the data is presented to better depict overall trends in the data.

Reference area data for temperature indicates a general warming trend and more consistent temperatures (diminished variation between mean and maximum temperatures) as the deployment period progressed. A similar pattern was also observed for salinity. In apparent response to increasing temperature, dissolved oxygen concentration declined steadily through the deployment period reaching a minimum of 3.5 mg/L on 8/14/98. It is also notable that the average DO concentrations increased as minimum DO values dropped rapidly from 8/10/98 to 8/15/98. This phenomena is attributed to wide swings in diel oxygen concentration which can occur as a result of phytoplankton production which will release O2 into the water column by day ands consume DO during nighttime respiration.

Stillwater Basin data for temperature indicates similar trends for temperature and salinity as found for the reference area; as the deployment period progressed waters were warmer and more saline. It is also noted that there are no major salinity drops that might reflect freshwater input from storm drains or runoff.

As with the reference area, a general depression in DO occurred from about 8/10-8/16/98 the minimum values were above 5 mg/L . In contrast to the reference area, mean and minimum DO concentrations trended together and the absolute difference between mean and minimum concentrations was less than that observed for the reference area. Hence, the water quality data suggests that it is unlikely that these measured parameters would cause a reduction in water quality supporting benthic community colonization.

3.2. Planform Photography Studies.

A total of 16 planform images of suitable quality for analysis were obtained in the Stillwater Basin area while 24 images were obtained at the reference location. Imagery for indicated locations are contained as an Arcview project on CD-ROM medium. In Stillwater Basin, two types of benthic cover were noted, the majority (62%) of stations consisting of sand only, while the remaining 38% of stations had a dominant cover consisting of sand with macrophytic algae. In contrast, 76% of locations at the reference area had a dominant cover consisting of sand with macrophytic algae, while only 4% were sand only. One additional station had dense algae which covered the bottom, and another was composed of shell lag with algae.

3.3. Sediment Profile Characterization Studies.

A total of 12 REMOTS® sediment-profile images of suitable quality for analysis were obtained in the Stillwater Basin area while 19 images were obtained at the reference location. Results of specific REMOTS® parameters are discussed in the following sections.

Camera Prism Penetration Depth. During the survey, weight was added to or removed from the REMOTS® camera frame to optimize penetration in the diverse types of sediment encountered across the surveyed areas. Therefore, it is not possible to use camera prism penetration depth as a direct comparative measure between areas. Nevertheless, the data shown in Table 3.3-1 reveal that a number stations at both locations exhibited poor ($\leq$ 3cm) penetration despite addition of weight attests to the bearing strength or density of underlying sediment (assumed to be compacted sand). This condition was found to occur at 42% of stations in Stillwater Basin but only at 31% of stations in the reference area. Hence the data suggest that sediment at depth is more likely composed of sand at Stillwater Basin than at the reference location. Still, a number of stations in Stillwater Basin had very deep penetration (> 15 cm), indicating that pockets of soft mud do exist in the survey area.

Sediment Grain Size Characterization. REMOTS® images reveal a relatively narrow range of particle sizes at both the stillwater basin and reference locations, ranging from moderately sorted sand (~2.5 phi) to silt-clay (>4 phi), with little, if any, difference in overall grain size major mode between areas (Table 3.1).

Apparent RPD Depths. Sands, which generally are characterized by low concentrations of ferrous hydroxides and organic material, tend to lack an obvious color contrast to mark the division between aerobic and anaerobic zones in the sediment column. This lack of color contrast makes it difficult to measure the depth of the apparent RPD with confidence at sandy stations. In images from the present survey where a high albedo sand layer overlaid a low reflectance mud layer, the apparent RPD depth was deemed to be equivalent to the depth of the sand layer.

The overall mean apparent RPD depth (± 1 standard deviation) for all replicate REMOTS® images obtained at the Stillwater Basin and reference area stations was 2.2± yyy cm and 1.8 ± yyy cm, respectively. The relatively high standard deviation indicates significant variance in the RPD among stations. The RPD was classified as indeterminate at stations where bottom hardness or compactness (e.g., sandy or rocky substrates) prevented adequate penetration of the REMOTS® camera prism, or at stations with extremely soft sediments where there was prism over-penetration.

At the reference area, stations exhibiting the deepest apparent RPD depths (i.e., > 3 cm) were were also associated with evidence of feeding voids; it is hypothesized that the downward transport of oxygen in these sediments is predominately controlled by mixing of the surface layers by organism bioturbation. Evidence of feeding voids was observed at only one Stillwater Basin Station, but active bioturbation was generally absent as the RPD was shallow (1.3 cm).

Sediments are presumed to have low dissolved oxygen when they exhibit extremely low reflectance (black color), without any color contrast to indicate a redox zone. At three Stillwater Basin stations (4105, 4107, 4110), the sediment appeared reduced (i.e., black or dark grey), suggesting high organic content, and relatively shallow apparent RPD depths of less than 1 cm were measured (Table 3.1).

Infaunal Successional Stages. At some stations where algae and/or rocks were the dominant sediment types, the penetration of the REMOTS® camera prism was hindered and the infaunal successional stage paradigm could not be applied. An "indeterminate" successional stage designation was applied to two reference stations (2516, 2520).

The benthic habitat of Stillwater Basin was composed primarily of Stage I (75% of stations). Only one station (4110) was completely azoic, while two remaining locations (4109, 4112) exhibited advanced community structure. Stage I structure was also found to be dominant benthic community type at the reference area, comprising 65% of stations where determinations were made. Hence, the data suggest that while the communities of Stillwater Basin are not complex, there is clear evidence that the majority of the habitat does have a viable community and that this condition is not specific to this location.

Sedimentary Methane. Evidence of methanogenesis was detected at Station DSY 41-10 by the appearance of a methane bubble in the sediment column (see file COD4110br.tif). This gas-filled void can be seen in the middle-right portion of the REMOTS® image as a generally circular and glassy object (due to the reflection of the strobe off the gas). The total areal coverage of the methane pocket was measured as 7.7 cm^2.

Organism-Sediment Index. Several reference locations had indeterminate OSI values; in most cases due to poor prism penetration prevented measurement of the RPD and/or determination of the infaunal successional stage. The mean overall OSI value for Stillwater Basin was +3.1, with values covering the full available range of -8 to +11. In contrast, the mean overall OSI value for the reference was nearly twice as high (+5.9), with individual stations exhibiting far less variation (range of +3 to +11 OSI units). Overall, the Stillwater Basin OSI are indicative of fair benthic habitat quality while the OSI values ~ +6 are indicative of relatively healthy benthic habitat conditions.

4.0 DISCUSSION

The stated objective of this investigation was to conduct a more detailed evaluation of the benthic environment so as to confirm, and if possible, determine the cause of azoic conditions.

With respect to the hypothesis that environmental quality of the water column in Stillwater Basin is sufficient to support the development of a balanced infaunal and epifaunal community, the results of this investigation support acceptance of the hypothesis. Benthic colonization studies revealed highly comparable patterns of epifaunal settlement on artificial substrates placed within Stillwater Basin and in a nearby reference area. No consistent trend of reduced community metrics in Stillwater Basin site relative to the reference area was observed which would suggest that reduced water quality in Stillwater Basin does contribute to a lack of benthic colonization in this area.

With regard to second hypothesis, that sediment quality in Stillwater Basin is sufficient to support the development of a balanced indigenous community, the results of this investigation support rejection of the hypothesis. Habitat quality assessment based on surficial (planform) and interfacial (REMOTS) sediment photographs at locations throughout the Stillwater Basin and reference areas indicate a general trend of reduced habitat quality in Stillwater Basin site relative to the reference area. Still, the data suggest that habitat quality was only somewhat less than the reference location, and clear evidence of Stage I benthic colonization was observed in the basin.

Derecktor Shipyard outfall sampling conducted 5/6/98 revealed total and fecal coliforms as well as Fecal streptococcus, enterococcus and *clostridium perfringens* which were greatly elevated in outfall waters (>1600 CFU) in comparison to runoff from roof samples (< 1000 CFU). This from bird nesting practices. These data suggest a source of raw sewage into Stillwater Basin which may account for the observed reduction in benthic habitat quality of the area. Also noted in the sampling was elevated chemical and biological oxygen demand of water from outfall station DSY-OF08-01 which is consistent with the shallow RPD values and evidence of methanogenesis in sediment. Finally, this station was found to be uniquely elevated in lead concentration (41.8 ug/L).

These findings are consistent with the results of the ERA investigation which noted elevated fecal indicator concentrations in deployed mussels at Station DSY-40 (ERA Figure 6.5-8) which happened also to be correlated with Low Molecular Weight PAH tissue residue concentrations. Although outfall water sampling did not measure PAH concentrations above detection, the fact that mussels time-integrate and bioaccumulate PAH concentrations would still allow the possibility that the PAH source to mussels was sewage-related. Mussels deployed at DSY-40 also exhibited the highest Pb concentrations for the entire study area (ERA Figure 4.3-9) which is consistent with Pb concentrations measured in outfall water.

The availability of these new data permit further interpretation of ERA findings as to source of ecological risks. Given the above findings for DSY-40, it is also notable that nearby ERA station DSY-29 was also considered lead-affected; percent dominant taxa increased with increasing lead concentration in sediment (ERA Figure 6.5-1); this station was also high for *Clostridium* in deployed mussels (ERA Figure 6.5-8). In the latter case, the fact that only *Clostridium* was elevated suggests a relict rather than recent fecal source because other indicator organisms do not survive for long periods in seawater. Finally, it would appear that the above linkage between apparent sewage enrichment and degraded benthic habitat may extend to another Shipyard station, DSY-26. Benthic colonization experiments noted that only this station exhibited a marked reduction in benthic colonization, albeit for only one deployment period (8/31/98; Table A3), and dissolved oxygen meter data indicated this location experienced temporary hypoxia (<4 mg/L; Figure 1). REMOTS and planview images confirm shallow RPDs and lush vegetation for this area, and the ERA investigation noted elevated fecal indicators (ERA Figure 5.3-5), elevated hematopoietic neoplasia (ERA Table 5.3-4), depressed growth in deployed mussels (ERA Figure 5.3-9) as well as diminished benthic community structure (ERA Table 5.3-2) at this location.

The hypothesis that outflows are environmentally significant in determining the quality of habitat in stillwater basin and other areas would appear to be relevant. At a minimum, these results suggest that important onshore sources of ecological risk may exist which should be addressed to ensure that any remedial action for CoCs in sediment will achieve the desired outcome over time.

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Figure 1. Time Series Water Quality Trends at Station DSY25/26

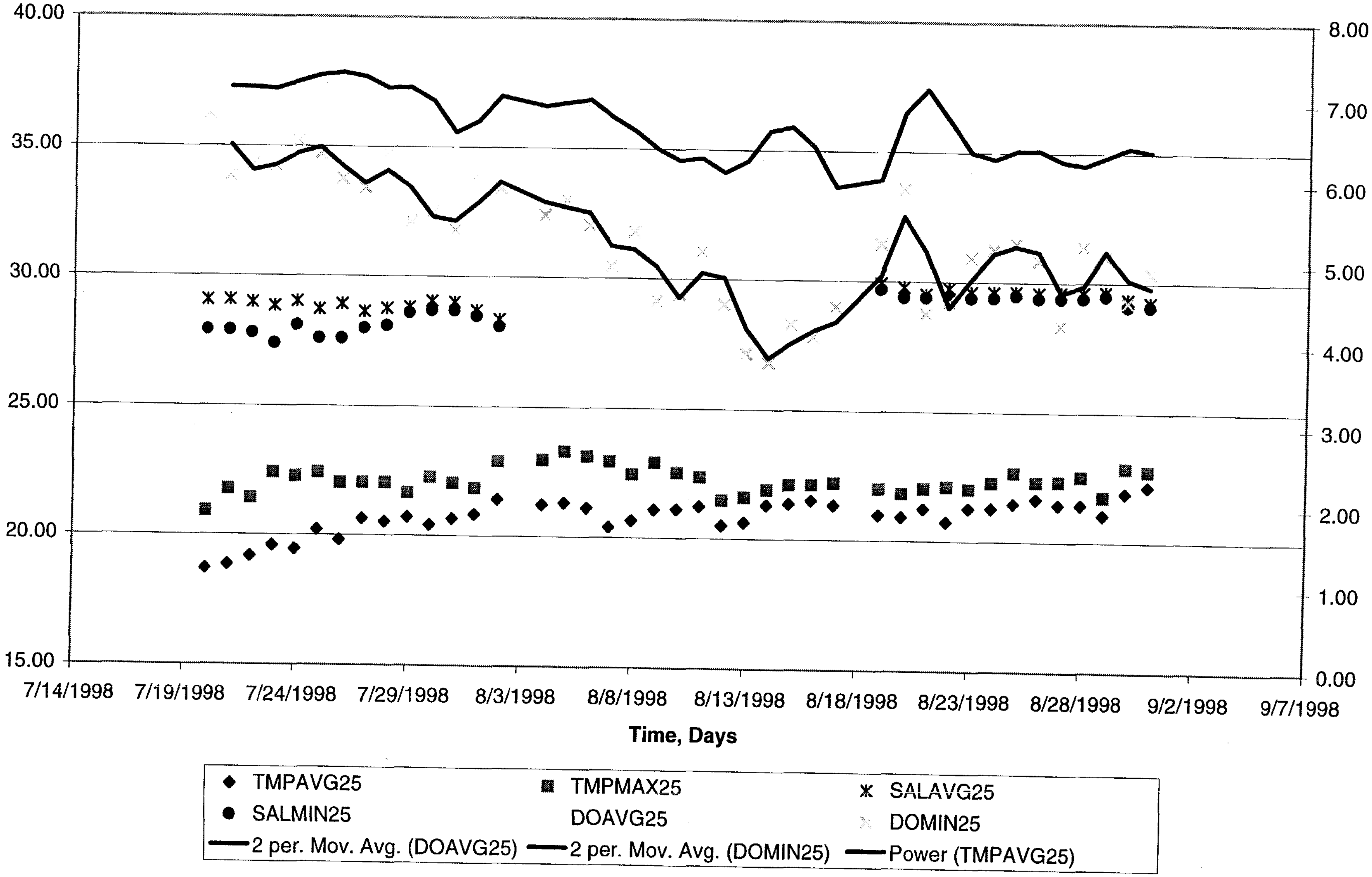

Figure 2. Time Series Water Quality Trends for DSY-40/41

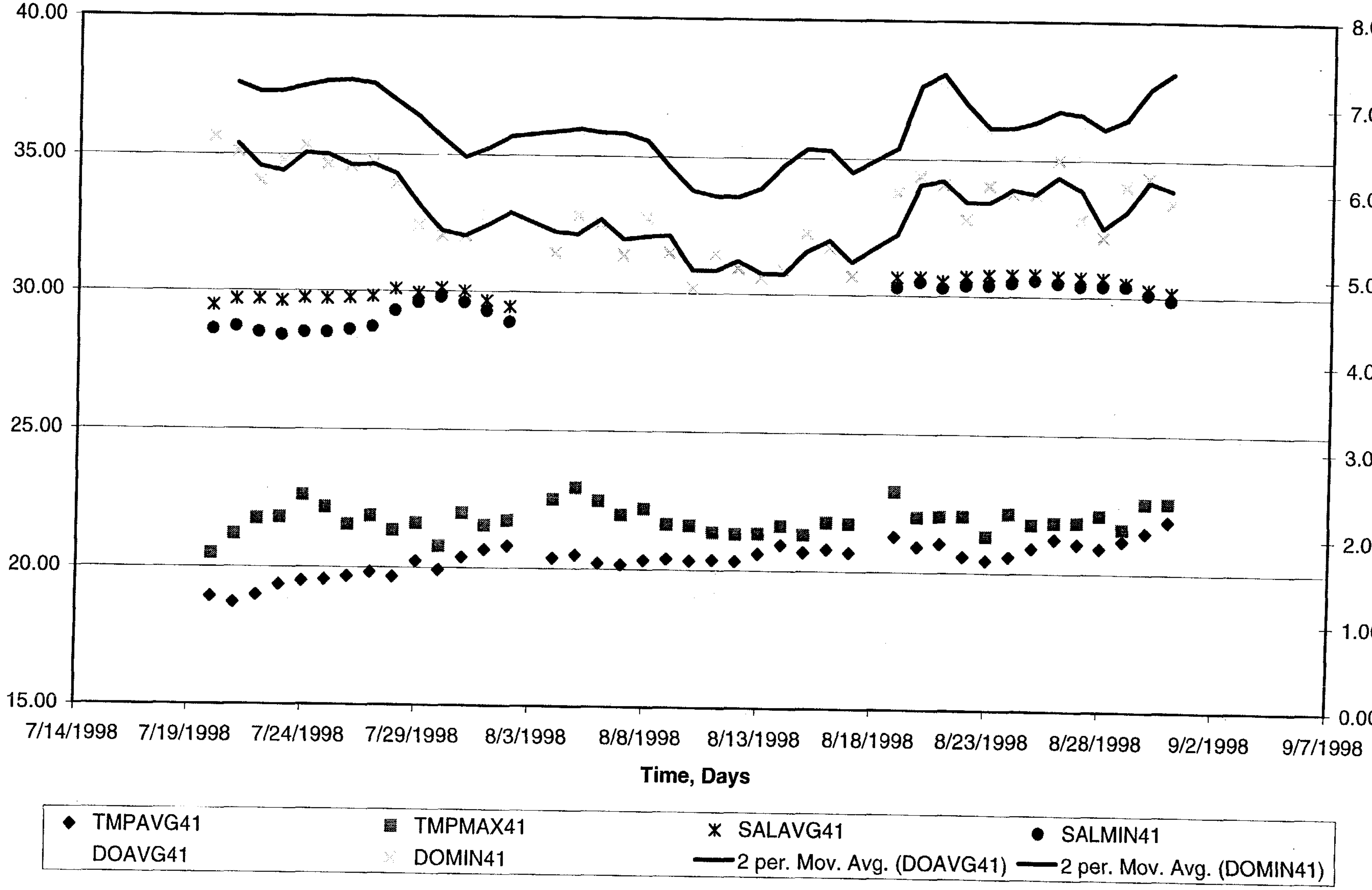

Table 3.1-1. Summary ecological statistics for communities settled on artificial substrate deployed in the Derecktor Shipyard/Coddington Cove study area.

	0.5 m deployment				Site Mean Comparison
A. 5/18/98 Retrieval	DSY-25/26 Overall		DSY-40/41 Overall		
Statistic	Mean	RPD%	Mean	RPD%	RPD%
Total number of taxa	18.8	24.0%	16.8	14.9%	11.3%
Total number of individuals	239.8	91.1%	179.8	3.6%	28.6%
Shannon-wiener diversity	1.97	24.4%	2.14	16.2%	-8.5%
Simpson's Dominance	0.26	78.6%	0.19	65.6%	33.7%
Species Richness	3.33	8.9%	3.04	17.4%	9.0%
Evenness	0.68	30.9%	0.77	20.9%	-11.8%
B. 7/2/98 Retrieval	DSY-25/26 Overall		DSY-40/41 Overall		
Statistic	Mean	RPD%	Mean	RPD%	RPD%
Total number of taxa	37.5	18.7%	34.3	7.3%	9.1%
Total number of individuals	1802.8	93.8%	1889.0	23.3%	-4.7%
Shannon-wiener diversity	2.41	13.6%	2.31	1.9%	4.1%
Simpson's Dominance	0.14	48.8%	0.14	0.7%	1.1%
Species Richness	4.97	4.3%	4.43	10.2%	11.6%
Evenness	0.67	8.2%	0.66	0.0%	1.9%
C. 8/31//98 Retrieval	DSY-25/26 Overall		DSY-40/41 Overall		
Statistic	Mean	RPD%	Mean	RPD%	RPD%
Total number of taxa	29.3	42.7%	28.0	14.3%	4.4%
Total number of individuals	485.3	67.7%	604.0	8.6%	-21.8%
Shannon-wiener diversity	2.24	24.3%	1.99	2.0%	11.9%
Simpson's Dominance	0.18	61.8%	0.21	9.6%	-16.2%
Species Richness	4.60	32.0%	4.22	13.4%	8.7%
Evenness	0.67	11.8%	0.60	1.9%	10.7%
	0.05 m deployment				
A. 7/2/98 Retrieval	DSY-25/26 Overall		DSY-40/41 Overall		
Statistic	Mean	RPD%	Mean	RPD%	RPD%
Total number of taxa	19.0	10.5%	21.3	25.9%	-11.2%
Total number of individuals	152.3	27.3%	434.8	47.7%	-96.3%
Shannon-wiener diversity	1.96	9.1%	1.78	2.8%	9.3%
Simpson's Dominance	0.25	34.6%	0.25	4.0%	-0.3%
Species Richness	3.61	16.1%	3.34	19.2%	7.6%
Evenness	0.67	11.9%	0.59	6.0%	13.1%
	0.05 m deployment				
B. 8/31/98 Retrieval	DSY-25/26 Overall		DSY-40/41 Overall		
Statistic	Mean	RPD%	Mean	RPD%	RPD%
Total number of taxa	13.3	124.5%	11.0	36.4%	18.6%
Total number of individuals	91.8	143.3%	168.5	29.1%	-59.0%
Shannon-wiener diversity	1.62	93.5%	1.34	22.7%	18.4%
Simpson's Dominance	0.36	121.5%	0.35	24.4%	2.7%
Species Richness	2.65	107.5%	1.96	34.3%	30.2%
Evenness	0.65	36.6%	0.57	7.8%	13.9%

Table 3.3-1. Summary of measurements extracted from REMOTS images collected for the Stillwater Basin Study.

Station	Sample Depth, (cm)	Grain Size Major Mode	RPD Depth, (cm)	Successional Stage	Org.-Sed. Index	Description
2501	1.4	2.5	INDET	ST_I	INDET	MUD; MOD SORTED
2502	1.4	3.5	1.2	ST_I	3	SAND; MOD SORTED; LOTS ALGAE; SHELL; TUNICATES
2503	2.3	2.5	1.6	ST_I	4	SAND; MOD SORTED
2504	3.2	3.5	1.3	ST_I_ON_III	7	SAND; MOD SORTED; FEEDING VOID
2505	0.9	3.5	INDET	ST_II	INDET	SAND; MOD SORTED; AMPHIPODS
2506	13.1	3.5	1.6	ST_I	4	MUD; WELL SORTED
2507	2.0	3.5	1.8	ST_I	4	SAND; WELL SORTED
2508	8.9	3.5	2.6	ST_I_ON_III	9	SAND/MUD; MOD SORTED
2509	4.2	3.5	1.1	ST_I_TO_II	4	SAND/MUD; MOD SORTED; HYPOXIC; JUV. AMPHIPOD MASS
2510	14.9	4	3.6	ST_I_ON_III	10	SAND/MUD; POORLY SORTED; FEEDING VOIDS
2511	15.6	4	4.1	ST_I_ON_III	11	SAND/MUD; POORLY SORTED; FEEDING VOIDS
2512	16.5	4	3.8	ST_I	7	SAND/MUD; MOD SORTED; FEEDING VOID
2513	9.0	3.5	2.3	ST_III	9	SAND/MUD; POORLY SORTED; ALGAE
2514	1.6	3.5	1.3	ST_I	3	SAND/MUD; POORLY SORTED; CTENOPHORE; SCOUR LAG
2515	4.9	3.5	2.7	ST_I	5	SAND/MUD; POORLY SORTED; SHELL FRAGSAND; RED ALGAE
2516	4.9	3.5	INDET	INDET	INDET	POORLY SORTED; LOTS ALGAE
2520	4.8	4	2.0	INDET	INDET	SAND/MUD; POORLY SORTED; SHELLS OR ROCK/SAND; ALGAE
2521	4.6	3.5	2.7	ST_I	5	SAND/MUD; POORLY SORTED; SHELL FRAG; SAND; ALGAE
2522	5.6	3.5	2.1	ST_I	4	MUD; POORLY SORTED; SHELL/SAND; ALGAE
Overall Characterization:	6.3	3.5	2.2	ST_I/ ST_I_ON_III	5.9	
4101	15.9	3.5	3.2	ST_I	6	SAND/MUD; POORLY SORTED;
4102	2.9	3.5	1.7	ST_I	4	SAND/MUD; POORLY SORTED; RIPPLED
4103	3.0	3.5	2.1	ST_I	4	SAND/MUD; POORLY SORTED
4104	2.7	2.5	1.7	ST_I	4	SAND/MUD; POORLY SORTED; SHELL LAG
4105	1.2	3.5	0.8	ST_I	-1	SAND/MUD; POORLY SORTED
4106	2.4	3.5	1.0	ST_I	3	SAND/MUD; POORLY SORTED; AMPHIPOD TUBE MAT
4107	13.1	4	0.8	ST_I	-1	MUD; WELL SORTED; HYPOXIC
4108	5.7	3.5	1.9	ST_I	4	SAND/MUD; POORLY SORTED; SHELL & TUBE LAG
4109	11.2	4	5.4	ST_III	11	THIN SAND/MUD; MOD SORTED
4110	19.6	4	0.0	AZOIC	-8	MUD; WELL SORTED; HYPOXIC; 1 METHANE BUBBLE
4111	5.3	3.5	2.1	ST_I	4	MUD; POORLY SORTED;
4112	15.3	4	1.3	ST_I_ON_III	7	MUD; MOD SORTED; FEEDING VOIDS
Overall Characterization:	8.2	3.6	1.8	ST_I/ ST_I_ON_III	3.1	

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Appendix A-1. Raw species counts for Hester Dende arrays deployed in Stillwater Basin (DSY-40/41) and Reference areas (DSY-25/26).

STUDY SITE = Narragansett Bay
STATION = 25
COLLECTION DATE = May 18, 1998
SIEVE SIZE = 0.3mm
COLLECTION GEAR = Hester-Dendy plates

TAXA	REP A	REP B	MEAN
NEMERTINEA			
Nemertinea	2	0	1.0
ANNELIDA			
Polynoidae	15	10	12.5
Polydora cornuta	7	9	8.0
Nereididae	10	2	6.0
Harmothoe imbricata	5	4	4.5
Exogone hebes	1	4	2.5
Terebellidae	2	1	1.5
Phyllodoce spp.	2	0	1.0
GASTROPODA			
Lacuna vincta	6	16	11.0
Nudibranchia	1	8	4.5
Gastropoda	2	0	1.0
BIVALVIA			
Mytilus edulis	37	25	31.0
Hiatella arctica	1	0	0.5
CRUSTACEA			
Balanus spp.	366	75	220.5
"Corophium" spp.	19	10	14.5
Apocorophium acutum	11	8	9.5
Dexamine thea	1	11	6.0
Limnoria lignorum	9	1	5.0
Microdeutopus spp.	2	3	2.5
Leptochelia savignyi	2	1	1.5
Paracaprella tenuis	3	0	1.5
Monocorophium sextonae	0	2	1.0
Microdeutopus anomalus	0	1	0.5
Leptocheirus spp.	0	1	0.5
Microdeutopus gryllotalpa	1	0	0.5
Caprella linearis	1	0	0.5

TOTAL NUMBER OF TAXA	23	19
TOTAL NUMBER OF INDIVIDUALS	506	192
SHANNON-WEINER DIVERSITY	1.278	2.178
SIMPSON'S DOMINANCE INDEX	0.533	0.192
SPECIES RICHNESS	3.53	3.42
EVENNESS	0.41	0.74

TOTAL STATION STATISTICS

TOTAL NUMBER OF TAXA	26
MEAN NUMBER OF INDIVIDUALS	349.0
SHANNON-WEINER DIVERSITY	1.618
SIMPSON'S DOMINANCE INDEX	0.414
SPECIES RICHNESS	3.82
EVENNESS	0.50

STUDY SITE = Narragansett Bay
STATION = 26
COLLECTION DATE = May 18, 1998
SIEVE SIZE = 0.3mm
COLLECTION GEAR = Hester-Dendy plates

TAXA	REP A	REP B	MEAN
NEMERTINEA			
Nemertinea	0	1	0.5
ANNELIDA			
Polynoidae	9	11	10.0
Harmothoe imbricata	6	2	4.0
Terebellidae	6	2	4.0
Proceraea cornuta	1	3	2.0
Phyllodoce spp.	2	1	1.5
Polydora cornuta	1	1	1.0
Nereididae	2	0	1.0
Eumida sanguinea	0	1	0.5
GASTROPODA			
Lacuna vincta	25	42	33.5
Astyris lunata	3	12	7.5
Nudibranchia	0	4	2.0
BIVALVIA			
Mytilus edulis	9	5	7.0
Hiatella arctica	0	4	2.0
Nucula spp.	0	1	0.5
CRUSTACEA			
Balanus spp.	11	25	18.0
Microdeutopus spp.	33	0	16.5
Limnoria lignorum	19	7	13.0
Microdeutopus anomalus	7	0	3.5
"Corophium" spp.	2	1	1.5
Microdeutopus gryllotalpa	2	0	1.0
TOTAL NUMBER OF TAXA	16	17	
TOTAL NUMBER OF INDIVIDUALS	138	123	
SHANNON-WEINER DIVERSITY	2.306	2.109	
SIMPSON'S DOMINANCE INDEX	0.132	0.184	
SPECIES RICHNESS	3.04	3.32	
EVENNESS	0.83	0.74	

TOTAL STATION STATISTICS

TOTAL NUMBER OF TAXA	21
MEAN NUMBER OF INDIVIDUALS	130.5
SHANNON-WEINER DIVERSITY	2.413
SIMPSON'S DOMINANCE INDEX	0.127
SPECIES RICHNESS	3.59
EVENNESS	0.79

STUDY SITE = Narragansett Bay
STATION = 40
COLLECTION DATE = May 18 1998
SIEVE SIZE = 0.3mm
COLLECTION GEAR = Hester-Dendy plates

TAXA	REP A	REP B	MEAN
NEMERTINEA			
Nemertinea	2	0	1.0
ANNELIDA			
Polydora cornuta	17	25	21.0
Polynoidae	1	10	5.5
Harmothoe imbricata	4	6	5.0
Ctenodrilus sp.	0	1	0.5
Phyllodoce spp.	0	1	0.5
GASTROPODA			
Lacuna vincta	16	13	14.5
Nudibranchia	0	12	6.0
Gastropoda	3	0	1.5
BIVALVIA			
Mytilus edulis	5	8	6.5
Hiatella arctica	1	0	0.5
CRUSTACEA			
Microdeutopus spp.	24	49	36.5
Balanus spp.	31	23	27.0
Limnoria lignorum	28	21	24.5
Microdeutopus anomalus	10	11	10.5
Monocorophium sextonae	11	5	8.0
"Corophium" spp.	5	3	4.0
Apocorophium acutum	2	4	3.0
Ericthonius spp.	1	0	0.5

TOTAL NUMBER OF TAXA	16	15
TOTAL NUMBER OF INDIVIDUALS	161	192
SHANNON-WEINER DIVERSITY	2.313	2.320
SIMPSON'S DOMINANCE INDEX	0.122	0.127
SPECIES RICHNESS	2.95	2.66
EVENNESS	0.83	0.86

TOTAL STATION STATISTICS

TOTAL NUMBER OF TAXA	19
MEAN NUMBER OF INDIVIDUALS	176.5
SHANNON-WEINER DIVERSITY	2.391
SIMPSON'S DOMINANCE INDEX	0.117
SPECIES RICHNESS	3.07
EVENNESS	0.81

STUDY SITE = Narragansett Bay
STATION = 41
COLLECTION DATE = May 18, 1998
SIEVE SIZE = 0.3mm
COLLECTION GEAR = Hester-Dendy plates

TAXA	REP A	REP B	MEAN
ANNELIDA			
Polydora cornuta	15	15	15.0
Harmothoe imbricata	5	15	10.0
Polynoidae	0	3	1.5
Ctenodrilus sp.	1	0	0.5
Proceraea cornuta	1	0	0.5
Brania clavata	1	0	0.5
Exogone spp.	0	1	0.5
GASTROPODA			
Lacuna vincta	20	6	13.0
Nudibranchia	2	2	2.0
Astyris lunata	0	2	1.0
Gastropoda	0	1	0.5
Doridella obscura	1	0	0.5
BIVALVIA			
Mytilus edulis	11	10	10.5
Hiatella arctica	1	0	0.5
CRUSTACEA			
Balanus spp.	136	9	72.5
Limnoria lignorum	29	36	32.5
Microdeutopus spp.	6	13	9.5
Microdeutopus anomalus	2	8	5.0
"Corophium" spp.	2	3	2.5
Dexamine thea	2	1	1.5
Gammarus spp.	2	1	1.5
Parametopella cypris	1	0	0.5
Monocorophium sextonae	0	1	0.5
Calliopius laeviusculus	0	1	0.5
TOTAL NUMBER OF TAXA	18	18	
TOTAL NUMBER OF INDIVIDUALS	238	128	
SHANNON-WEINER DIVERSITY	1.613	2.327	
SIMPSON'S DOMINANCE INDEX	0.356	0.136	
SPECIES RICHNESS	3.11	3.50	
EVENNESS	0.56	0.81	

STUDY SITE = Narragansett Bay
STATION = 25
COLLECTION DATE = July 2, 1998
SIEVE SIZE = 0.5mm
COLLECTION GEAR = Hester-Dendy Plates

TAXA	REP A	REP C	REP D	REP E	MEAN
NEMERTINEA					
Nemertinea	0	2	0	0	0.5
ANNELIDA					
Polydora cornuta	163	57	3	0	55.8
Nereididae	57	37	4	6	26.0
Brania clavata	15	13	0	0	7.0
Harmothoe imbricata	5	11	0	1	4.3
Terebellidae	11	4	1	0	4.0
Eumida sanguinea	7	9	0	0	4.0
Exogone hebes	9	6	0	0	3.8
Ctenodrilus sp.	8	5	0	0	3.3
Phyllodoce mucosa	6	5	0	0	2.8
Polynoidae	5	2	0	0	1.8
Phyllodoce spp.	0	3	0	0	0.8
Spirorbis sp.	2	0	0	0	0.5
Proceraea cornuta	1	1	0	0	0.5
Syllidae	1	0	0	0	0.3
Onuphidae	0	1	0	0	0.3
Ophryotrocha sp.	1	0	0	0	0.3
Neanthes virens	1	0	0	0	0.3
GASTROPODA					
Lacuna vincta	21	16	36	30	25.8
Astyris lunata	20	15	3	0	9.5
Anachis lafresnayi	2	1	0	2	1.3
Crepidula spp.	3	1	0	0	1.0
Nudibranchia	0	1	0	0	0.3
Gastropoda	0	1	0	0	0.3
BIVALVIA					
Mytilus edulis	40	36	6	15	24.3
Mya arenaria	7	8	0	0	3.8
Hiatella arctica	0	1	0	0	0.3
Nucula proxima	1	0	0	0	0.3
CRUSTACEA					
Microdeutopus spp.	544	508	52	80	296.0
Dexamine thea	389	351	2	3	186.3
Monocorophium sextonae	360	329	14	14	179.3
Microdeutopus anomalus	171	187	6	17	95.3
Apocorophium acutum	172	143	9	15	84.8
Balanus crenatus	177	110	0	0	71.8
Limnoria lignorum	78	63	1	1	35.8
Janiropsis sp. A	34	31	1	0	16.5
Caprellidae	50	4	3	0	14.3

Corophium spp.	19	16	2	0	9.3
Leptochelia savignyi	14	23	0	0	9.3
Microdeutopus gryllotalpa	9	5	0	0	3.5
Jassa marmorata	11	0	0	0	2.8
Stenothoe valida	0	8	0	0	2.0
Paracaprella tenuis	4	3	1	0	2.0
Caprella linearis	3	0	2	2	1.8
Dyspanopeus sayi	0	0	0	1	0.3
DIPTERA					
Chironomidae	1	1	0	0	0.5
ECHINODERMATA					
Asteroidea	0	0	0	3	0.8
UROCHORDATA					
Ascidia obliqua	272	362	1	3	159.5
Ciona intestinalis	139	82	0	4	56.3
Botryllus schlosseri	1	1	1	1	1.0
TOTAL NUMBER OF TAXA	41	41	19	17	
TOTAL NUMBER OF INDIVIDUALS	2834	2463	148	198	
SHANNON-WEINER DIVERSITY	2.637	2.507	2.076	2.016	
SIMPSON'S DOMINANCE INDEX	0.100	0.117	0.201	0.212	
SPECIES RICHNESS	5.03	5.12	3.60	3.03	
EVENNESS	0.71	0.68	0.71	0.71	

TOTAL STATION STATISTICS

TOTAL NUMBER OF TAXA	50
MEAN NUMBER OF INDIVIDUALS	1410.8
SHANNON-WEINER DIVERSITY	2.616
SIMPSON'S DOMINANCE INDEX	0.106
SPECIES RICHNESS	5.67
EVENNESS	0.67

STUDY SITE = Narragansett Bay
STATION = 26
COLLECTION DATE = July 2, 1998
SIEVE SIZE = 0.5mm
COLLECTION GEAR = Hester-Dendy Plates

TAXA	REP A	REP C	REP D	REP E	MEAN
PLATYHELMINTHES					
Turbellaria	1	0	0	0	0.3
ANNELIDA					
Polydora cornuta	92	25	4	0	30.3
Capitella capitata complex	5	0	83	0	22.0
Nereididae	32	11	5	1	12.3
Harmothoe imbricata	10	9	2	6	6.8
Proceraea cornuta	12	1	4	0	4.3
Terebellidae	5	1	0	0	1.5
Phyllodoce mucosa	3	2	0	0	1.3
Eumida sanguinea	1	2	0	1	1.0
Neanthes virens	0	0	3	0	0.8
Brania clavata	3	0	0	0	0.8
Ophryotrocha sp.	3	0	0	0	0.8
Oligochaeta	0	0	0	2	0.5
Ctenodrilus sp.	2	0	0	0	0.5
Brada villosa	0	0	1	0	0.3
Polynoidae	1	0	0	0	0.3
GASTROPODA					
Astyris lunata	94	46	11	12	40.8
Lacuna vincta	24	50	1	3	19.5
Anachis lafresnayi	15	6	3	0	6.0
Nudibranchia	8	2	0	0	2.5
Crepidula spp.	0	1	6	2	2.3
Bittium alternatum	0	1	0	0	0.3
BIVALVIA					
Tellina agilis	14	0	2	0	4.0
Nucula proxima	1	0	4	0	1.3
Mytilus edulis	0	0	1	0	0.3
CRUSTACEA					
Microdeutopus spp.	581	155	27	49	203.0
Monocorophium sextonae	137	57	2	1	49.3
Microdeutopus anomalus	69	52	2	10	33.3
Limnoria lignorum	58	19	2	0	19.8
Parametopella cypris	51	4	0	0	13.8
Apocorophium acutum	7	0	0	0	1.8
Gammarus spp.	2	1	2	0	1.3
Chelura terebrans	4	1	0	0	1.3
Corophium spp.	4	1	0	0	1.3
Paracaprella tenuis	4	0	0	0	1.0
Leptochelia savignyi	2	0	0	1	0.8
Caprellidae	3	0	0	0	0.8

Stenothoe valida	3	0	0	0	0.8
Dyspanopeus sayi	0	1	1	1	0.8
Caprella linearis	0	2	0	1	0.8
Balanus crenatus	1	1	0	0	0.5
Janiropsis sp. A	2	0	0	0	0.5
Ischyrocerus anguipes	1	0	0	0	0.3
Jassa marmorata	1	0	0	0	0.3
Crangon septemspinosa	0	0	0	1	0.3
Microprotopus raneyi	0	1	0	0	0.3
Luconacia incerta	0	1	0	0	0.3
Ericthonius brasiliensis	1	0	0	0	0.3
Leptocheirus pinguis	0	0	1	0	0.3
Pontogeneia inermis	0	0	0	1	0.3
Calliopius laeviusculus	0	0	1	0	0.3
Cancer irroratus	0	0	1	0	0.3
ECHINODERMATA					
Asteroidea	1	0	0	0	0.3
UROCHORDATA					
Ciona intestinalis	150	51	0	0	50.3
Botryllus schlosseri	1	1	1	1	1.0
TOTAL NUMBER OF TAXA	40	28	24	16	
TOTAL NUMBER OF INDIVIDUALS	1409	505	170	93	
SHANNON-WEINER DIVERSITY	2.213	2.275	2.004	1.733	
SIMPSON'S DOMINANCE INDEX	0.206	0.151	0.273	0.313	
SPECIES RICHNESS	5.38	4.34	4.48	3.31	
EVENNESS	0.60	0.68	0.63	0.63	

TOTAL STATION STATISTICS

TOTAL NUMBER OF TAXA	55
MEAN NUMBER OF INDIVIDUALS	544.3
SHANNON-WEINER DIVERSITY	2.398
SIMPSON'S DOMINANCE INDEX	0.174
SPECIES RICHNESS	7.03
EVENNESS	0.60

STUDY SITE = Narragansett Bay
STATION = 40
COLLECTION DATE = July 2, 1998
SIEVE SIZE = 0.5mm
COLLECTION GEAR = Hester-Dendy Plates

TAXA	REP A	REP C	REP D	REP E	MEAN
NEMERTINEA					
Nemertinea	0	0	0	1	0.3
ANNELIDA					
Polydora cornuta	269	414	177	103	240.8
Nereididae	74	117	41	24	64.0
Eumida sanguinea	6	7	2	3	4.5
Harmothoe imbricata	7	6	1	3	4.3
Exogone spp.	5	10	0	0	3.8
Brania clavata	3	5	4	1	3.3
Proceraea cornuta	7	3	0	0	2.5
Polynoidae	5	2	1	0	2.0
Phyllodoce mucosa	2	4	0	0	1.5
Terebellidae	1	4	1	0	1.5
Phyllodoce spp.	4	1	0	0	1.3
Neanthes succinea	0	0	0	3	0.8
Dipolydora socialis	0	1	0	0	0.3
GASTROPODA					
Crepidula spp.	2	10	6	34	13.0
Astyris lunata	26	4	0	1	7.8
Nudibranchia	1	20	1	0	5.5
Lacuna vincta	5	1	4	4	3.5
Crepidula plana	0	0	11	0	2.8
BIVALVIA					
Anomia simplex	0	2	0	0	0.5
Mytilus edulis	1	1	0	0	0.5
Mya arenaria	0	1	0	0	0.3
Nucula proxima	0	0	0	1	0.3
CRUSTACEA					
Microdeutopus spp.	394	678	100	60	308.0
Monocorophium sextonae	252	416	10	13	172.8
Microdeutopus anomalus	146	154	26	16	85.5
Limnoria lignorum	23	118	0	1	35.5
Apocorophium acutum	31	63	1	0	23.8
Balanus crenatus	13	78	1	0	23.0
Corophium spp.	19	14	0	0	8.3
Dexamine thea	18	10	0	0	7.0
Parametopella cypris	6	13	1	0	5.0
Stenothoe valida	6	6	0	0	3.0
Leptochelia savignyi	4	3	0	0	1.8
Ampelisca abdita	0	0	2	1	0.8
Cancer irroratus	3	0	0	0	0.8
Caprella linearis	0	1	0	0	0.3

ECHINODERMATA					
Asteroidea	1	0	0	0	0.3
UROCHORDATA					
Ascidia obliqua	158	319	1	0	119.5
Ciona intestinalis	122	116	0	0	59.5
Botryllus schlosseri	1	1	1	1	1.0
TOTAL NUMBER OF TAXA	**32**	**34**	**20**	**17**	
TOTAL NUMBER OF INDIVIDUALS	**1615**	**2603**	**392**	**270**	
SHANNON-WEINER DIVERSITY	**2.313**	**2.264**	**1.666**	**1.849**	
SIMPSON'S DOMINANCE INDEX	**0.138**	**0.145**	**0.286**	**0.225**	
SPECIES RICHNESS	**4.20**	**4.20**	**3.18**	**2.86**	
EVENNESS	**0.67**	**0.64**	**0.56**	**0.65**	

TOTAL STATION STATISTICS

TOTAL NUMBER OF TAXA	**41**
MEAN NUMBER OF INDIVIDUALS	**1220.0**
SHANNON-WEINER DIVERSITY	**2.317**
SIMPSON'S DOMINANCE INDEX	**0.144**
SPECIES RICHNESS	**4.71**
EVENNESS	**0.62**

STUDY SITE = Narragansett Bay
STATION = 41
COLLECTION DATE = July 2, 1998
SIEVE SIZE = 0.5mm
COLLECTION GEAR = Hester-Dendy Plates

TAXA	REP A	REP 2	REP D	REP 4	MEAN
PLATYHELMINTHES					
Turbellaria	1	0	0	0	0.3
ANNELIDA					
Polydora cornuta	163	152	148	43	126.5
Nereididae	108	82	24	32	61.5
Harmothoe imbricata	2	7	5	4	4.5
Eumida sanguinea	3	8	2	3	4.0
Capitella capitata complex	0	0	3	7	2.5
Terebellidae	2	6	0	0	2.0
Proceraea cornuta	4	1	1	0	1.5
Phyllodoce mucosa	2	2	1	0	1.3
Tharyx sp. A	0	0	5	0	1.3
Polynoidae	0	2	1	2	1.3
Brania clavata	1	2	1	0	1.0
Exogone spp.	2	1	0	0	0.8
Pygospio elegans	0	0	0	1	0.3
Spiophanes bombyx	0	0	1	0	0.3
Phyllodoce spp.	0	1	0	0	0.3
Oligochaeta	0	0	0	1	0.3
Neanthes succinea	1	0	0	0	0.3
GASTROPODA					
Nudibranchia	24	14	0	2	10.0
Astyris lunata	5	29	4	0	9.5
Lacuna vincta	13	5	3	3	6.0
Crepidula spp.	1	4	2	2	2.3
Crepidula plana	0	0	0	1	0.3
Gastropoda	0	1	0	0	0.3
Doridella obscura	1	0	0	0	0.3
BIVALVIA					
Mya arenaria	0	0	3	5	2.0
Mytilus edulis	1	5	0	0	1.5
Anomia simplex	2	0	0	0	0.5
PYCNOGONIDA					
Achelia spinosa	1	0	0	0	0.3
CRUSTACEA					
Microdeutopus spp.	322	294	97	177	222.5
Microdeutopus anomalus	135	136	26	62	89.8
Balanus crenatus	183	111	1	0	73.8
Monocorophium sextonae	100	144	15	12	67.8
Limnoria lignorum	19	65	2	1	21.8

Apocorophium acutum	34	24	0	0	14.5
Dexamine thea	25	17	2	0	11.0
Corophium spp.	2	18	1	0	5.3
Parametopella cypris	4	9	0	0	3.3
Stenothoe valida	5	1	0	0	1.5
Paracaprella tenuis	4	1	0	1	1.5
Janiropsis sp. A	0	2	0	0	0.5
Ischyrocerus anguipes	2	0	0	0	0.5
Cancer irroratus	1	0	1	0	0.5
Ampelisca abdita	0	1	0	0	0.3
Dyspanopeus sayi	0	0	0	1	0.3
Caprella linearis	0	1	0	0	0.3
ECHINODERMATA					
Asteroidea	14	5	6	1	6.5
UROCHORDATA					
Ascidia obliqua	562	333	261	98	313.5
Ciona intestinalis	23	80	0	0	25.8
Botryllus schlosseri	1	1	1	1	1.0
TOTAL NUMBER OF TAXA	**36**	**35**	**26**	**22**	
TOTAL NUMBER OF INDIVIDUALS	**1773**	**1565**	**617**	**460**	
SHANNON-WEINER DIVERSITY	**2.207**	**2.458**	**1.749**	**1.866**	
SIMPSON'S DOMINANCE INDEX	**0.166**	**0.119**	**0.265**	**0.226**	
SPECIES RICHNESS	**4.68**	**4.62**	**3.89**	**3.43**	
EVENNESS	**0.62**	**0.69**	**0.54**	**0.60**	

TOTAL STATION STATISTICS

TOTAL NUMBER OF TAXA	**50**
MEAN NUMBER OF INDIVIDUALS	**1103.8**
SHANNON-WEINER DIVERSITY	**2.306**
SIMPSON'S DOMINANCE INDEX	**0.154**
SPECIES RICHNESS	**5.84**
EVENNESS	**0.59**

TOTAL STATION STATISTICS

TOTAL NUMBER OF TAXA	24
MEAN NUMBER OF INDIVIDUALS	183.0
SHANNON-WEINER DIVERSITY	2.057
SIMPSON'S DOMINANCE INDEX	0.211
SPECIES RICHNESS	3.90
EVENNESS	0.65

Study Site = Narragansett Bay
Station = 25
Collection date = August 1998
Sieve Size = 0.5mm
Gear = Hester-Dendy Plates

Taxa	Rep A	Rep C	Rep D	Rep E
ANNELIDA				
Ampharetidae	1			
Capitella capitata	2			
Demonax microphthalma	3	7		
Eumida sanguinea	21	22	9	14
Exogone hebes	6	13		3
Grubeosyllis clavata	8	10	5	2
Harmothoe imbricata			5	5
Hydroides dianthus	89	91	3	11
Maldanidae	1			
Oligochaeta	1		1	
Phyllodoce arenae				1
Podarke obscura	9	8		
Polydora cornuta	51	79	20	21
Sabellidae	1			
Spirorbidae		3		
Spirorbis sp.	1			
Terebellidae	2	3		1
CRUSTACEA				
Aeginella longicornis		1		
Ampithoe emarginata	3	6		2
Ampithoe longimana			1	
Balanus crenatus	4	5		1
Caprella penantis		2		
Caprellidea	2	8		2
Dexamine thea	6	18	3	2
Dyspanopeus sayi	1	2	1	1
Ianiropsis sp.		1	1	1
Leptochelia savignyi	37	37	5	12
Limnoria lignorum		4		
Microdeutopsis anomalis	20	41	15	3
Monocorophium sextonae	114	136	10	9
Paracaprella tenuis		2	1	
Rhithropanopeus harrisii	1	1		
MOLLUSCA				

Anachis lafresnayi	1	4		
Anadara transversa	1	1		
Astyris lunata	11	4		
Crepidula fornicata	3	2		
Crepidula plana	35	44	29	67
Littorina littorea		1		
Nudibranchia		1		
Turbonilla elegantula	1	1	4	14
OTHER				
Asicidia obliqua	67	194	1	21
Botrylloides diegenesis*	1	1	1	
Botryllus schlosseri*	1	1	1	1
Nemertea		3		
Turbellaria	14	16	3	1
Urochordata	4	3		1
Total individuals per rep. =	523	776	119	196
Total individuals per sta. 25 = 1614				
Mean number individuals = 403.5				
Total taxa per replicate =	34	37	20	23
Total taxa per station = 46				
Mean number taxa per rep. = 11.5				

* colonial species; presence indicated by the number 1

Study Site = Narragansett Bay
Station = 26
Collection date = August 1998
Sieve Size = 0.5mm
Gear = Hester-Dendy Plates

Taxa	Rep A	Rep C	Rep D	Rep E
ANNELIDA				
Capitella capitata	3	2		
Demonax microphthalma	2			
Eumida sanguinea	2			
Grubeosyllis clavata	1			
Harmothoe imbricata		1		
Hydroides dianthus		1		
Oligochaeta		1		
Polydora cornuta	95	176		
Terebellidae	2			
CRUSTACEA				
Ampithoe emarginata	2	25		
Balanus crenatus	26	8		
Cancer borealis	1			
Cancer irroratus	1			
Caprellidea	5	3		
Dyspanopeus sayi	1			
Jassa marmorata			1	1
Leptochelia savignyi	1	1	1	
Limnoria lignorum		1		
Microdeutopsis anomalis	18	89	1	
Monocorophium sextonae	4	33		
Paracaprella tenuis		1		
Stenothoe sp.	2	1		
MOLLUSCA				
Anachis lafresnayi	1			
Astyris lunata	29	12		1
Crepidula plana	23	33	19	20
Gastropoda	1			
Nucula proxima			3	4
Tellina sp.				1
OTHER				
Asicidia obliqua	2	9		
Botrylloides diegenesis*	1	1		

Botryllus schlosseri*	1			
Nemertea	10	4		
Turbellaria	1	3		
Urochordata		2		
Total individuals per rep. =	235	407	25	27
Total individuals per sta. 26 = 694				
Mean number individuals = 173.5				
Total taxa per replicate =	25	21	5	5
Total taxa per station = 34				
Mean number taxa per rep. = 8.5				

* colonial species; presence indicated by the number 1

Study Site = Narragansett Bay
Station = 40
Collection date = August 1998
Sieve Size = 0.5mm
Gear = Hester-Dendy Plates

Taxa	Rep A	Rep C	Rep D	Rep E
ANNELIDA				
Capitella capitata			10	8
Demonax microphthalma	6	2		
Eumida sanguinea	20	16		3
Exogone hebes	4	3		
Grubeosyllis clavata	1	1		
Harmothoe imbricata				1
Hydroides dianthus	40	55		
Maldanidae	1			
Neanthes succinea			2	
Oligochaeta		1		
Phyllodoce arenae		1		
Phyllodocidae		1		
Podarke obscura	4	1		
Polydora cornuta	170	162	91	62
Spirorbidae	1			
Terebellidae	1			
CRUSTACEA				
Ampelisca sp.	1			1
Ampithoe emarginata		1		1
Balanus crenatus	4	3		
Calliopius laeviusculus			1	
Decapoda (megalopae)	1			
Dexamine thea	1			
Dyspanopeus sayi		5		
Ianiropsis sp.	1			
Leptochelia savignyi	1	1		
Microdeutopsis anomalis	105	9	2	5
Monocorophium sextonae	63	45		
Paracaprella tenuis			1	
Trichophoxus epistomus	1			
Xanthidae	1			
MOLLUSCA				
Astyris lunata		4		
Crepidula fornicata		1		

Crepidula plana	26	43	50	46
Nudibranchia		1		
Turbonilla elegantula				1
OTHER				
Asicidia obliqua	158	163		
Botrylloides diegenesis*	1	1		
Botryllus schlosseri*	1	1		
Nemertea		2		2
Turbellaria	10	6		1
Urochordata	3	1		
Total individuals per rep. =	626	530	157	131
Total individuals per sta. 40 = 1444				
Mean number individuals = 361				
Total taxa per replicate =	26	26	7	11
Total taxa per station = 41				
Mean number taxa per rep. = 10.25				

* colonial species; presence indicated by the number 1

Study Site = Narragansett Bay
Station = 41
Collection date = August 1998
Sieve Size = 0.5mm
Gear = Hester-Dendy Plates

Taxa	Rep A	Rep C	Rep D	Rep E
ANNELIDA				
Capitella capitata			1	
Demonax microphthalma	2	7		
Eumida sanguinea	15	35	3	9
Exogone hebes	2	3		
Grubeosyllis clavata	1	1		
Hydroides dianthus	28	90	1	2
Maldanidae		1		
Phyllodoce arenae		1		
Pista palmata				1
Podarke obscura	5	2		
Polydora cornuta	145	315	94	54
Polynoidae		1		
Sabellidae	1			
Serpulidae	1	1		
Terebellidae	1	4		
CRUSTACEA				
Ampelisca sp.				1
Ampithoe emarginata	16			1
Balanus crenatus	2	9		1
Caprellidea	1	2		
Dexamine thea	1	20		
Dyspanopeus sayi	5			1
Ianiropsis sp.		2	1	
Leptochelia savignyi	3			
Limnoria lignorum		3		1
Microdeutopsis anomalis	47	54	61	82
Monocorophium sextonae	26	25	2	2
Mysidacea			4	
Xanthidae	2			
MOLLUSCA				
Anachis lafresnayi		1		
Anadara ovalis		1		
Astyris lunata	2	3		1
Crepidula fornicata		1		

Crepidula plana	30	34	24	12
Gastropoda		1		
Gemma gemma				1
Mysella planulata		1		
Nudibranchia		1		
OTHER				
Asicidia obliqua	169	120	14	11
Botrylloides diegenesis*	1	1		1
Botryllus schlosseri*	1	1		
Nemertea	2	1		
Turbellaria	3	2		
Urochordata	3	1		
Total individuals per rep. =	515	745	205	181
Total individuals per sta. 41 = 1646				
Mean number individuals = 411.5				
Total taxa per replicate =	27	33	10	16
Total taxa per station = 43				
Mean number taxa per rep. = 10.75				

* colonial species; presence indicated by the number 1

Table A2. Summary ecological statistics for communities settled on artificial substrate deployed 0.5 meters above bottom (mab) in the Derecktor Shipyard/Coddington Cove study area.

A. 5/18/98 Retrieval	Station DSY-25 0.5 mab				Station DSY-26 0.5 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	23	19	21.0	19%	16	17	16.5	6%	18.8	24%
Total number of individuals	506	192	349	90%	138	123	130.5	11%	239.8	91%
Shannon-wiener diversity	1.28	2.18	1.73	52%	2.31	2.11	2.21	9%	1.97	24%
Simpson's Dominance	0.53	0.19	0.36	94%	0.13	0.18	0.16	33%	0.26	79%
Species Richness	3.53	3.42	3.48	3%	3.04	3.32	3.18	9%	3.33	9%
Evenness	0.41	0.74	0.58	57%	0.83	0.74	0.79	11%	0.68	31%
	Station DSY-40 0.5 mab				Station DSY-41 0.5 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	16	15	15.5	6%	18	18	18.0	0%	16.8	15%
Total number of individuals	161	192	176.5	18%	238	128	183.0	60%	179.8	4%
Shannon-wiener diversity	2.31	2.32	2.32	0%	1.61	2.33	1.97	36%	2.14	16%
Simpson's Dominance	0.12	0.13	0.12	4%	0.36	0.14	0.25	89%	0.19	66%
Species Richness	2.95	2.60	2.78	13%	3.11	3.50	3.31	12%	3.04	17%
Evenness	0.83	0.86	0.85	4%	0.56	0.81	0.69	36%	0.77	21%

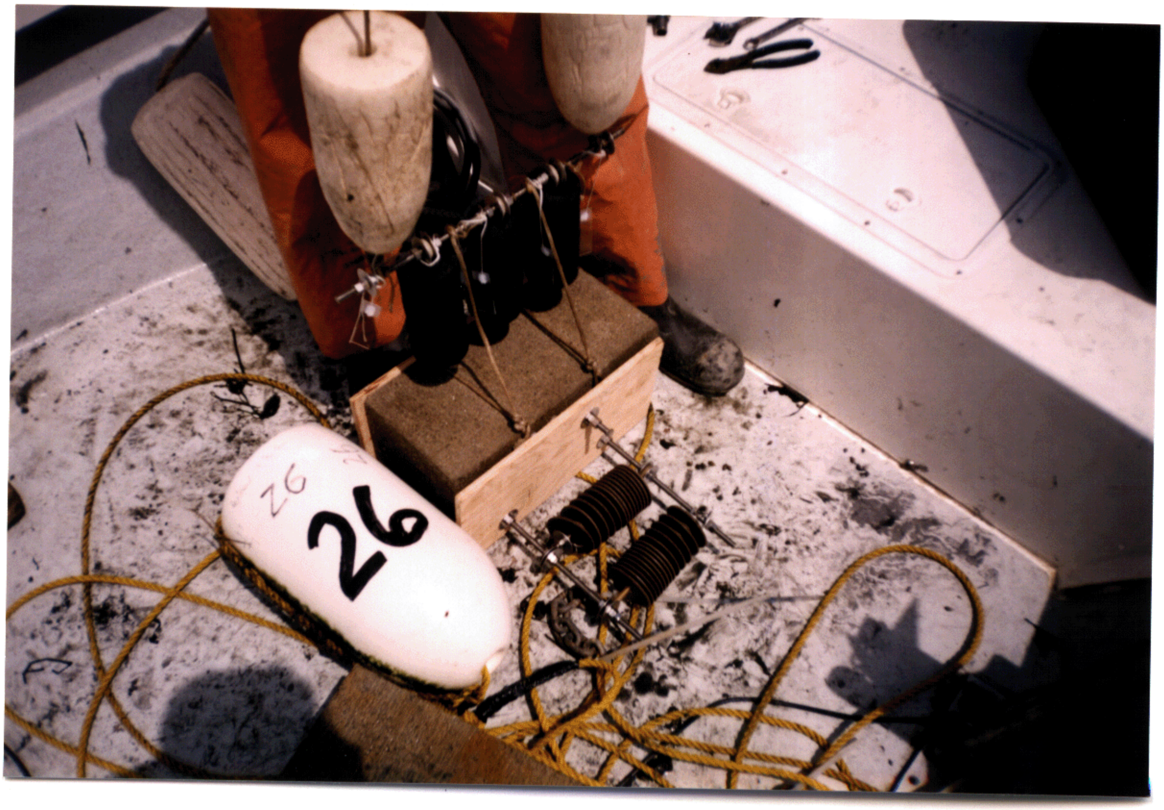
B. 7/2/98 Retrieval	Station DSY-25 0.5 mab				Station DSY-26 0.5 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	41	41	41.0	0%	40	28	34.0	35%	37.5	19%
Total number of individuals	2834	2463	2648.5	14%	1409	505	957.0	94%	1802.8	94%
Shannon-wiener diversity	2.64	2.51	2.57	5%	2.21	2.28	2.24	3%	2.41	14%
Simpson's Dominance	0.10	0.12	0.11	16%	0.21	0.15	0.18	31%	0.14	49%
Species Richness	5.03	5.12	5.08	2%	5.38	4.34	4.86	21%	4.97	4%
Evenness	0.71	0.68	0.70	4%	0.60	0.68	0.64	13%	0.67	8%
	Station DSY-40 0.5 mab				Station DSY-41 0.5 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	32	34	33.0	6%	36	35	35.5	3%	34.3	7%
Total number of individuals	1615	2603	2109	47%	1773	1565	1669.0	12%	1889.0	23%
Shannon-wiener diversity	2.31	2.26	2.29	2%	2.21	2.46	2.33	11%	2.31	2%
Simpson's Dominance	0.14	0.15	0.14	5%	0.17	0.12	0.14	33%	0.14	1%
Species Richness	4.20	4.20	4.20	0%	4.68	4.62	4.65	1%	4.43	10%
Evenness	0.67	0.64	0.66	5%	0.62	0.69	0.66	11%	0.66	0%

C. 8/31/98 Retrieval	Station DSY-25 0.5 mab				Station DSY-26 0.5 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	34	37	35.5	8%	25	21	23.0	17%	29.3	43%
Total number of individuals	523	776	649.5	39%	235	407	321.0	54%	485.3	68%
Shannon-wiener diversity	2.53	2.50	2.52	1%	2.11	1.83	1.97	14%	2.24	24%
Simpson's Dominance	0.12	0.13	0.12	9%	0.21	0.25	0.23	19%	0.18	62%
Species Richness	5.27	5.41	5.34	3%	4.40	3.33	3.87	28%	4.60	32%
Evenness	0.72	0.69	0.71	3%	0.66	0.60	0.63	9%	0.67	12%
	Station DSY-40 0.5 mab				Station DSY-41 0.5 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	26	26	26.0	0%	27	33	30.0	20%	28.0	14%
Total number of individuals	626	530	578	17%	515	745	630.0	37%	604.0	9%
Shannon-wiener diversity	2.02	1.92	1.97	5%	2.03	1.99	2.01	2%	1.99	2%
Simpson's Dominance	0.18	0.21	0.20	16%	0.21	0.23	0.22	11%	0.21	10%
Species Richness	3.88	3.99	3.94	3%	4.16	4.84	4.50	15%	4.22	13%
Evenness	0.62	0.59	0.60	5%	0.62	0.57	0.59	8%	0.60	2%

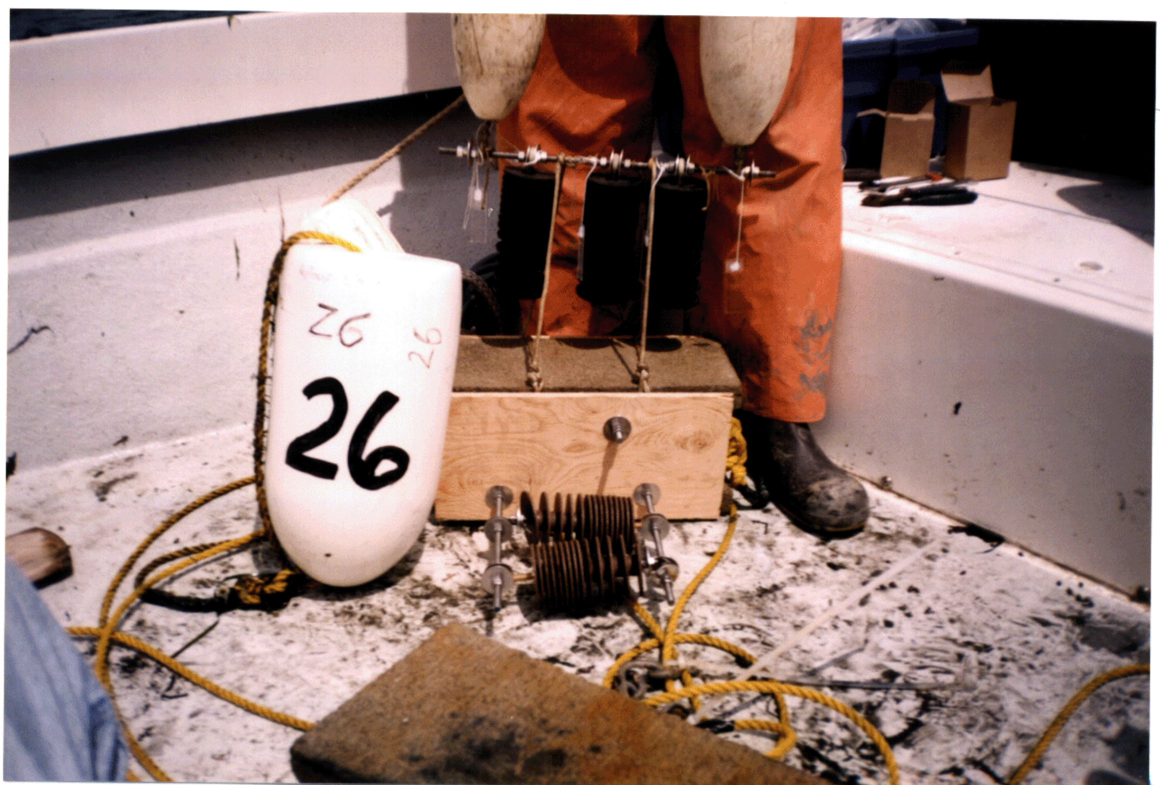
Table A3. Summary ecological statistics for communities settled on artificial substrate deployed 0.05 meters above bottom (mab) in the Derecktor Shipyard/Coddington Cove study area.

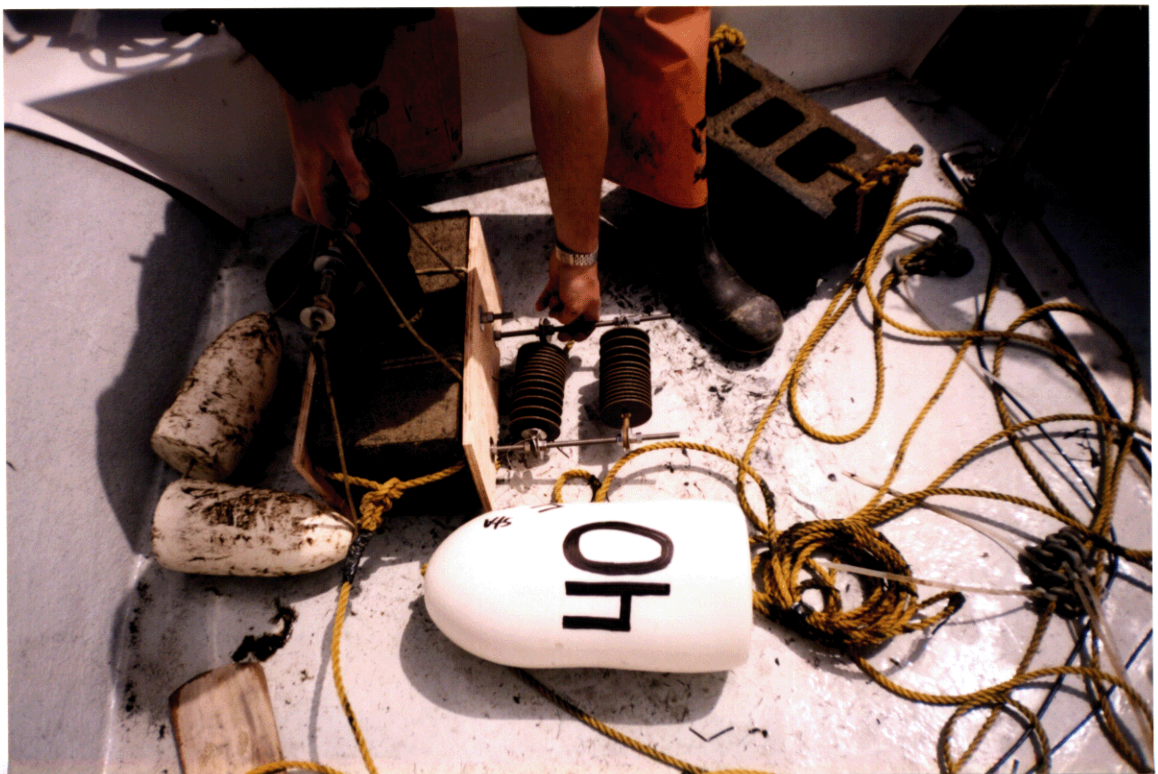
A. 5/18/98 Retrieval	Station DSY-25 0.05 mab				Station DSY-26 0.05 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	ND	ND			ND	ND				
Total number of individuals	ND	ND			ND	ND				
Shannon-wiener diversity	ND	ND			ND	ND				
Simpson's Dominance	ND	ND			ND	ND				
Species Richness	ND	ND			ND	ND				
Evenness	ND	ND			ND	ND				
	Station DSY-40 0.05 mab				Station DSY-41 0.05 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	ND	ND			ND	ND				
Total number of individuals	ND	ND			ND	ND				
Shannon-wiener diversity	ND	ND			ND	ND				
Simpson's Dominance	ND	ND			ND	ND				
Species Richness	ND	ND			ND	ND				
Evenness	ND	ND			ND	ND				
B. 7/2//98 Retrieval	Station DSY-25 0.05 mab				Station DSY-26 0.05 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	19	17	18.0	11%	24	16	20.0	40%	19.0	11%
Total number of individuals	148	198	173	29%	170	93	131.5	59%	152.3	27%
Shannon-wiener diversity	2.08	2.02	2.05	3%	2.00	1.73	1.87	15%	1.96	9%
Simpson's Dominance	0.20	0.21	0.21	5%	0.27	0.31	0.29	14%	0.25	35%
Species Richness	3.60	3.03	3.32	17%	4.48	3.31	3.90	30%	3.61	16%
Evenness	0.71	0.71	0.71	0%	0.63	0.63	0.63	0%	0.67	12%
	Station DSY-40 0.05 mab				Station DSY-41 0.05 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	20	17	18.5	16%	26	22	24.0	17%	21.3	26%
Total number of individuals	392	270	331	37%	617	460	538.5	29%	434.8	48%
Shannon-wiener diversity	1.67	1.85	1.76	10%	1.75	1.87	1.81	6%	1.78	3%
Simpson's Dominance	0.29	0.23	0.26	24%	0.27	0.23	0.25	16%	0.25	4%
Species Richness	3.18	2.86	3.02	11%	3.89	3.43	3.66	13%	3.34	19%
Evenness	0.56	0.65	0.61	15%	0.54	0.60	0.57	11%	0.59	6%
C. 8/31//98 Retrieval	Station DSY-25 0.05 mab				Station DSY-26 0.05 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	20	23	21.5	14%	5	5	5.0	0%	13.3	125%
Total number of individuals	119	196	157.5	49%	25	27	26.0	8%	91.8	143%
Shannon-wiener diversity	2.42	2.32	2.37	4%	0.85	0.87	0.86	3%	1.62	93%
Simpson's Dominance	0.13	0.16	0.14	25%	0.60	0.58	0.59	4%	0.36	122%
Species Richness	3.98	4.17	4.08	5%	1.24	1.21	1.23	2%	2.65	108%
Evenness	0.81	0.74	0.77	9%	0.53	0.54	0.53	2%	0.65	37%
	Station DSY-40 0.05 mab				Station DSY-41 0.05 mab				Overall	
Statistic	REP A	REP C	Mean	RPD%	REP A	REP C	Mean	RPD%	Mean	RPD%
Total number of taxa	7	11	9.0	44%	10	16	13.0	46%	11.0	36%
Total number of individuals	157	131	144	18%	205	181	193.0	12%	168.5	29%
Shannon-wiener diversity	1.03	1.35	1.19	27%	1.41	1.58	1.50	11%	1.34	23%
Simpson's Dominance	0.44	0.35	0.40	22%	0.32	0.31	0.31	4%	0.35	24%
Species Richness	1.19	2.05	1.62	53%	1.69	2.89	2.29	52%	1.96	34%
Evenness	0.53	0.56	0.55	6%	0.61	0.57	0.59	8%	0.57	8%

Photos of early summer Hester Dende deployment array, Station 25
May 1998



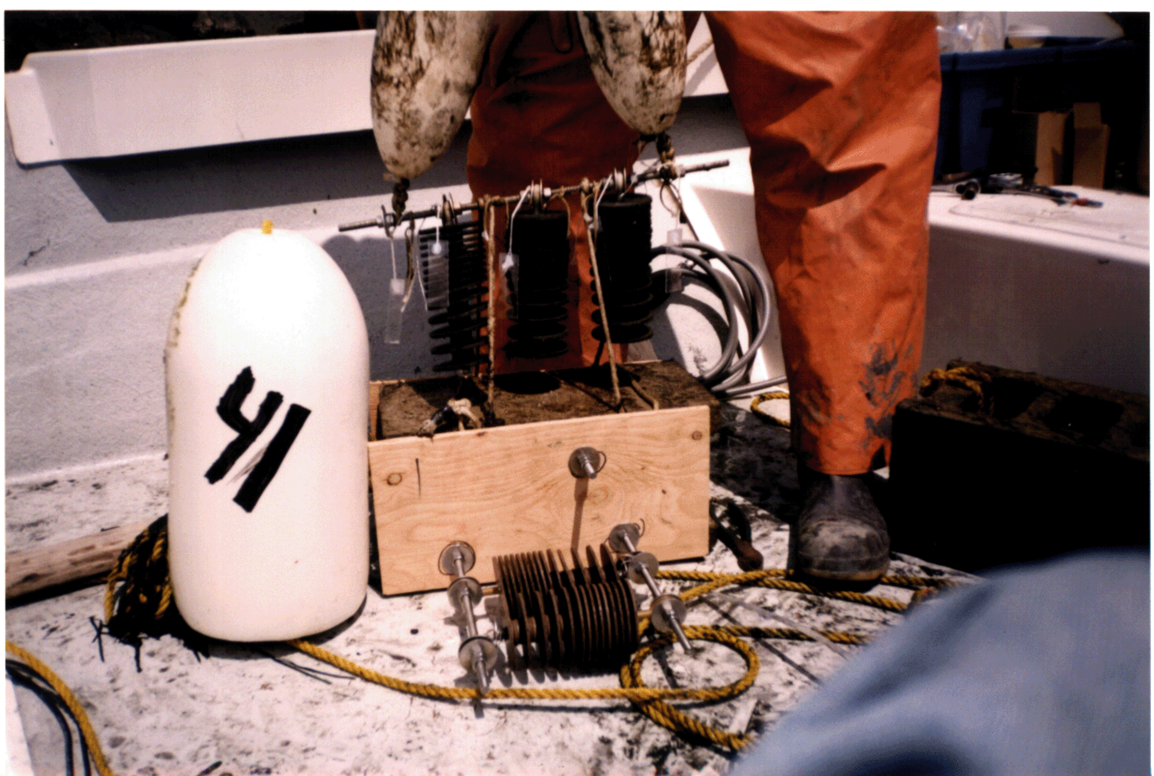
Photos of early summer Hester Dende deployment array, Station 26
May 1998





Photos of early summer Hester Dende deployment array, Station 40
May 1998

Photos of early summer Hester Dende deployment array, Station 41
May 1998



APPENDIX D
DATA VALIDATION MEMORANDA AND DATA TABLES, OUTFALL WATER SAMPLES

Brown & Root Environmental INTERNAL CORRESPONDENCE

C-Navy-7-98-1205W

To: Steve Parker cc: File 7752-4.10

From: Maureen Parker MP

Subject: Tier II Data Validation, Navy CLEAN CTO 0302
Project No. 7752, SDG OF0401
Ceimic Corporation
NETC (Former Derecktor Shipyard) Newport, Rhode Island

Total Metals/BOD/COD/TDS/TSS/Total Coliform/Fecal Coliform/
Fecal Strep/Enterococcus/Clostridium Perfingens/: 8/Waters/
DSY-OF04-01, DSY-OF05-01, DSY-OF06-01,
DSY-OF07-01, DSY-OF08-01, DSY-OF09-01,
DSY-OF09A-01, DSY-OFDUP-01

Date: July 9, 1998

Brown and Root (B&R) Environmental performed a tier II data validation on the total metals, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), total suspended solids (TSS), total coliform, fecal coliform, fecal strep, enterococcus and clostridium perfingens data from SDG OF0401, low level water samples collected by Brown and Root Environmental (B&RE) at the former Derecktor Shipyard site. The total metals samples were analyzed in accordance with the CLP inorganic statement of work (SOW) ILM04.0. The BOD samples were analyzed by Method 405.1. The COD samples were analyzed by Method 410.4. The TDS samples were analyzed by Method 160.1. The TSS samples were analyzed by Method 160.2. The total coliform samples were analyzed by Standard Method 9221B. The fecal coliform samples were analyzed by Standard Method 9221E. The fecal strep and enterococcus samples were analyzed by Standard Method 9230B. The clostridium perfringens samples were analyzed by EPA/600/R 95/030. The data were evaluated based on the following parameters:

- o Data Completeness
- o Holding Times
- o Calibration Verification
- o Field and Laboratory Blank Analyses
- * o ICP Interference Check Sample Results
- * o Matrix Spike Recoveries
- * o Laboratory Control Sample Results
- * o Laboratory Duplicate Results
- * o Field Duplicate Precision
- * o ICP Serial Dilution Results

* - All quality control criteria were met for this parameter.

Data Completeness

No quality control data or raw data were submitted with the microbial data. CRDL standard percent recoveries were incorrectly calculated for several compounds. A corrected Form II was requested on June 23, 1998 and was received on June 25, 1998. The laboratory was contacted on July 3, 1998 because the methods used for the general chemistry analyses were not listed in the case narrative. A revised case narrative was faxed to B&RE on July 7, 1998.

Holding Times

The total coliform results for DSY-OF04-01, DSY-OF05-01 and DSY-OF06-01 were not confirmed by the laboratory due to an error on the chain of custody. The results for total coliform for samples DSY-OF04-01, DSY-OF05-01 and DSY-OF06-01 are estimated, (J).

Calibration Verification

The CRDL Standard Analysis Percent Recoveries (%Rs) for lead, manganese and zinc were above the 120% quality control criteria and were below the 80% quality control criteria for copper, nickel, silver and vanadium. Positive results < 3 x CRDL for copper, lead, manganese, nickel, silver, vanadium and zinc are qualified as estimated, (J). Non-detected results for copper, nickel, silver and vanadium are qualified as estimated, (UJ).

Blanks

The laboratory blank analyses were used to calculate the following action levels based on the maximum concentrations indicated:

Analyte	Maximum Concentration (μg/L)	Action Level (μg/L)
Aluminum	106.9	534.5
Arsenic	-6.5	32.5
Barium	11.9	59.5
Cadmium	0.4	2.0
Calcium	488	2440
Copper	-20.6	103
Iron	35.8	179
Lead	1.8	9.0

Blanks CONT'D:

Analyte	Maximum Concentration (µg/L)	Action Level (µg/L)
Magnesium	210.6	1053
Manganese	5.4	27
Potassium	412.8	2064
Sodium	557.2	2786
Thallium	2.6	13
Zinc	9.5	47.5

Value > 2x IDL and < Action Level = Report value U.
Value < 2x IDL and/or < CRDL and < Action Level = Report value UJ.
Value > IDL and > Action Level = Report value unqualified.

Blank actions are required for aluminum, arsenic, barium, cadmium, copper, iron, lead, magnesium, manganese, potassium, thallium and zinc. No qualifications are required for calcium and sodium because the positive results are greater than the action levels.

Field Duplicate Precision

The TSS result for sample DSY-OF09-01 is 7.0 mg/L while the TSS result for the field duplicate sample DSY-OFDUP-01 is non-detected. The positive and non-detected results for the affected duplicate pair are qualified as estimated, (J and UJ) respectively.

Overall Assessment of the Data

The data are acceptable for use as qualified. Positive results < 3 x CRDL and non-detected results for copper, lead, manganese, nickel, silver, vanadium and zinc are estimated due to poor linearity at low concentrations. Aluminum, arsenic, barium, cadmium, copper, iron, lead, magnesium, manganese, potassium, thallium and zinc detection limits were raised due to blank contamination. The TSS results for samples DSY-OF09-01 and DSY-OFDUP-01 are estimated due to poor field duplicate precision. The positive and non-detected results The total coliform results for DSY-OF04-01, DSY-OF05-01 and DSY-OF06-01 were not confirmed by the laboratory due to an error on the chain of custody, therefore the results for total coliform for these samples are estimated, (J).

NOTE: Sample results below 2x IDL and/or < CRDL are estimated due to uncertainty near the instrument detection limits.

Attachments
cc: File 7752-4.10

Aqueous TAL Metal Analysis (ug/l)
Site: Derecktor Shipyard Outfall Sampling
Case: 7752; SDG: OF0401

EPA Sample Number	DSY-OF04-01		DSY-OF05-01		DSY-OF06-01		DSY-OF07-01		DSY-OF08-01		DSY-OF09-01		DSY-OF09A-01		DSY-OFDUP-01	
Station Location	DSY-OF04-01		DSY-OF05-01		DSY-OF06-01		DSY-OF07-01		DSY-OF08-01		DSY-OF09-01		DSY-OF09A-01		DSY-OFDUP-01	
Date Sampled	5/5/98		5/5/98		5/5/98		5/6/98		5/6/98		5/6/98		5/6/98		5/6/98	
Date Extracted																
Date Analyzed																
Dilution Factor	1		1		1		1		1		1		1		1	
Percent Solids	0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
QC Identifier	None		None		None		None		None		Field Duplicate 1		None		Field Duplicate 1	
Aluminum	93.3	U	671		44.8	UJ	56.0	UJ	4250		213	U	314	U	252	U
Antimony	6.2		2.3	U	2.4	J	2.3	U	2.6	J	2.3	U	2.3	U	2.3	U
Arsenic	2.3	U	2.3	U	2.3	U	2.3	U	3.4	UJ	2.3	U	2.3	U	2.3	U
Barium	10.8		21.0	U	10.8	U	10.8	U	24.5	U	10.2	U	9.8	U	9.1	U
Beryllium	0.61	U	0.61	U	0.61	U	0.61	U	0.63	J	0.61	U	0.61	U	0.61	U
Cadmium	0.32	UJ	0.45	UJ	0.46	UJ	0.27	UJ	0.27	U	0.35	UJ	0.32	UJ	0.33	UJ
Calcium	40000		11700		39400		3540		12200		20600		9710		21200	
Chromium	6.6	U	6.6	U	6.6	U	6.6	U	6.6	U	6.6	U	6.6	U	6.6	U
Cobalt	5.7	U	5.7	U	5.7	U	5.7	U	5.7	U	5.7	U	5.7	U	5.7	U
Copper	6.4	UJ	11.1	UJ	5.5	UJ	25.1	UJ	69.9	UJ	6.4	UJ	15.5	UJ	5.5	UJ
Iron	102	U	1600		71.7	U	54.7	U	9560		657		613		676	
Lead	3.6	UJ	9.7		1.7	U	2.2	UJ	41.8		1.7	U	5.8	UJ	5.2	UJ
Magnesium	4060		2740		2420		523	U	4080		22100		2320		22300	
Manganese	5.8	UJ	37.3	J	5.0	UJ	7.5	UJ	202		51.4		22.7	UJ	51.4	
Mercury	0.13	J	0.27		0.13	U	0.41		0.13	U	0.47		1.5		0.13	U
Nickel	6.8	UJ	6.8	UJ	6.8	UJ	7.0	J	17.0	J	6.8	UJ	6.8	UJ	6.8	UJ
Potassium	10400		2150		5180		368	UJ	2380		8670		1960	U	8580	
Selenium	3.6	U	3.6	U	3.6	U	3.6	U	3.6	U	3.6	U	3.6	U	3.6	U
Silver	2.8	UJ	2.8	UJ	2.8	UJ	2.8	UJ	2.8	UJ	2.8	UJ	2.8	UJ	2.8	UJ
Sodium	17300		12800		10700		3070		12500		174000		9290		176000	
Thallium	2.6	UJ	3.4	U	1.7	U	1.7	U	1.7	U	3.3	UJ	1.7	U	3.1	UJ
Vanadium	5.8	UJ	5.8	UJ	5.8	UJ	5.8	UJ	9.1	J	5.8	UJ	5.8	UJ	5.8	UJ
Zinc	106		46.1	UJ	34.0	UJ	81.8		116		8.3	UJ	16.7	UJ	8.8	UJ

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; EB/TB - Equipment/Trip Blank contamination

Aqueous Water Quality Analysis (mg/l)
Site: Derecktor Shipyard Outfall Sampling
Case: 7752; SDG: OF0401

EPA Sample Number	DSY-OF04-01		DSY-OF05-01		DSY-OF06-01		DSY-OF07-01		DSY-OF08-01		DSY-OF09-01		DSY-OF09A-01		DSY-OFDUP-01	
Station Location	DSY-OF04-01		DSY-OF05-01		DSY-OF06-01		DSY-OF07-01		DSY-OF08-01		DSY-OF09-01		DSY-OF09A-01		DSY-OFDUP-01	
Date Sampled	5/5/98		5/5/98		5/5/98		5/6/98		5/6/98		5/6/98		5/6/98		5/6/98	
Date Extracted																
Date Analyzed																
Dilution Factor	1		1		1		1		1		1		1		1	
Percent Solids	0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
QC Identifier	None		None		None		None		None		Field Duplicate 1		None		Field Duplicate 1	
Biochemical Oxygen Demand	2	U	2	U	2	U	2	U	5.7		4.6		5.8		4.3	
Chemical Oxygen Demand	9.6		24.9		32.2		12.2		56		52.9		53.7		51.4	
Total Dissolved Solids	206		92.5		164		27.5		101		614		90		620	
Total Suspended Solids	5	U	18		5	U	5	U	133		7	J	6		5	UJ

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected;

Aqueous Water Quality Analysis (mg/l)
Site: Derecktor Shipyard Outfall Sampling
Case: 7752; SDG: OF0401

EPA Sample Number	DSY-OF04-01	DSY-OF05-01	DSY-OF06-01	DSY-OF07-01	DSY-OF08-01	DSY-OF09-01	DSY-OF09A-01	DSY-OFDUP-01
Station Location	DSY-OF04-01	DSY-OF05-01	DSY-OF06-01	DSY-OF07-01	DSY-OF08-01	DSY-OF09-01	DSY-OF09A-01	DSY-OFDUP-01
Date Sampled	5/5/98	5/5/98	5/5/98	5/6/98	5/6/98	5/6/98	5/6/98	5/6/98
Date Extracted								
Date Analyzed	5/6/98	5/6/98	5/6/98	5/7/98	5/7/98	5/7/98	5/7/98	5/7/98
Dilution Factor	1	1	1	1	1	1	1	1
Percent Solids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
QC Identifier	None	None	None	None	None	Field Duplicate 1	None	Field Duplicate 1
Total Coliform MPN/100 ml	900 J	≥ 1600 J	240 J	≥ 1600	≥ 1600	≥ 1600	≥ 1600	≥ 1600
Fecal Coliform MPN/100 ml	900	≥ 1600	30	≥ 1600	≥ 1600	≥ 1600	≥ 1600	≥ 1600
Fecal Strep MPN/100 ml	500	≥ 1600	30	≥ 1600	≥ 1600	≥ 1600	≥ 1600	≥ 1600
Enterococcus MPN/100 ml	500	≥ 1600	30 U	≥ 1600	≥ 1600	≥ 1600	≥ 1600	≥ 1600
Clostridium Perfingens CFU/100 ml	29	11	1 U	1	300	210	1000	160

Roof ↑ Roof Roof ↑ ↑ ↑ ↑

DUPLS

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; MPN-Most Probable Number; CFU-Colony Forming Units

Brown & Root Environmental

INTERNAL CORRESPONDENCE

C-Navy-7-98-1206W

To: Stephen Parker

cc: File 7752-4.10

From: Maureen Parker MP

Subject: Tier II Data Validation, Navy CLEAN CTO 0302
Project No. 7752, SDG OF0401
Ceimic Corporation
NETC (Former Derecktor Shipyard) Newport, Rhode Island

SVOC/PCB: 8 /Waters/
DSY-OF04-01, DSY-OF05-01, DSY-OF06-01,
DSY-OF07-01, DSY-OF08-01, DSY-OF09-01,
DSY-OF09A-01, DSY-OFDUP-01

Date: July 9, 1998

Brown and Root Environmental (B&RE) performed a tier II data validation on the semivolatile organic compounds (SVOC) and polychlorinated biphenyls (PCB) data from Project 7752, water samples collected by B&RE at the Derecktor shipyard site. The samples were analyzed according to Method CLP SOW OLM03.2. The semivolatile data validations were performed using the Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, December 1996 criteria. The PCB data validation was performed according to the Region I, EPA Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses, November 1988.

The data were evaluated based on the following parameters:

- o Data Completeness (CSF Audit - Tier I)
- * o Preservation and Technical Holding Times
- * o GC/MS Instrument Performance Check (Tuning)
- o Initial and Continuing Calibrations
- o Blanks
- o Surrogate Compounds
- * o Laboratory Control Spikes
- * o Internal Standards
- o Matrix Spike/Matrix Spike Duplicate
- * o Field Duplicates
- * o System Performance

* - All criteria were met for this parameter.

Data Completeness

The laboratory was contacted on June 28, 1998 regarding a typographical error for the % resolution on Form VI Pest-6. The laboratory faxed the corrected Form VI on June 30, 1998.

Calibrations

Semivolatiles

The following tables summarize the semivolatile initial (IC) and continuing calibration (CC) compounds which failed to meet the calibration criteria of %RSD <30 and %D <25:

Instrument	MS4	MS4	Action		Affected Samples
Compound	IC 5/18/98	CC 5/23/98	(+)	NDs	
Hexachlorocyclo pentadiene	%RSD = 45.9	%D = - 50		UJ	DSY-OF09A-01, DSY-OFDUP-01, DSY-OF09-01
2,4-Dinitrophenol	%RSD = 57.5	%D = - 68.8		UJ	DSY-OF09A-01, DSY-OFDUP-01, DSY-OF09-01
2-Methylphenol		%D = 32.9		UJ	DSY-OF09A-01, DSY-OFDUP-01, DSY-OF09-01
4-Nitrophenol		%D = - 46.1		UJ	DSY-OF09A-01, DSY-OFDUP-01, DSY-OF09-01
Pentachlorophenol		%D = - 31.0		UJ	DSY-OF09A-01, DSY-OFDUP-01, DSY-OF09-01

The non-detected results for hexachlorocyclopentadiene, 2,4-dinitrophenol, 2-methylphenol, 4-nitrophenol and pentachlorophenol are qualified as estimated (UJ) in affected samples.

Instrument	MS4	MS4	Action		Affected Samples
Compound	CC 5/19/98	CC 5/20/98	(+)	NDs	
Hexachloro benzene	%D = 26.8	%D = 27.3		UJ	DSY-OF06-01, DSY-OF04-01, DSY-OF07-01, DSY-OF08-01

CONT'D:

Instrument	MS4	MS4	Action		Affected Samples
Compound	CC 5/19/98	CC 5/20/98	(+)	NDs	
2,4-Dinitrophenol	%D = -54.7			UJ	DSY-OF06-01
Di-n-octylphthalate		%D = 31.6		UJ	DSY-OF04-01, DSY-OF07-01, DSY-OF08-01

The non-detected results for hexachlorobenzene, 2,4-dinitrophenol and di-n-octylphthalate are qualified as estimated (UJ) in affected samples.

Other compounds with non-compliant calibrations which do not affect the reported sample results are not listed here.

Blanks

The following contaminants at the maximum concentrations were found in the laboratory blanks associated with the samples:

Compound	Type of Blank	Max. Conc.	Action Level µg/L	CRQL µg/L
Benzo(k)fluoranthene	Method	1 µg/L	5	10
Benzo(g,h,i)perylene	Method	1µg/L	5	10

No blank actions are necessary since there are no positive results reported for the above compounds.

Surrogate Recoveries

The surrogate spike recoveries for decachlorobiphenyl are below the 30% quality control criteria for several samples. No actions are necessary since the quality control limits are advisory only.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Semivolatile

The following table summarizes the semivolatile matrix spiking compound recovery which did not meet QC limits in the matrix spike and matrix spike duplicate analysis of sample DSY-OF06-01:

DSY-OF06-01							
Compound	MS %REC	MSD %REC	QC Limits	RPD	QC Limits	Action	
						(+)	ND
4-Nitrophenol	83		10 - 80				None

No action is necessary for the non-detected result for 4-nitrophenol in sample DSY-OF06-01.

Overall Assessment

The results should be used as qualified. The non-detected results for hexachlorocyclopentadiene, 2,4-dinitrophenol, 2-methylphenol, 4-nitrophenol, pentachlorophenol, hexachlorobenzene and di-n-octylphthalate are estimated in several samples due to an initial calibration %RSD > 30% and/or a continuing calibration %D >25.

Attachments
cc: File 7752-4.10

Aqueous Semivolatile Organic Analysis (ug/l)
Site: Derecktor Shipyard Outfall Sampling
Case: 7752; SDG: OF0401

EPA Sample Number	DSY-OF04-01	DSY-OF05-01	DSY-OF06-01	DSY-OF07-01	DSY-OF08-01	DSY-OF09-01	DSY-OF09A-01	DSY-OFDUP-01
Station Location	DSY-OF04-01	DSY-OF05-01	DSY-OF06-01	DSY-OF07-01	DSY-OF08-01	DSY-OF09-01	DSY-OF09A-01	DSY-OFDUP-01
Date Sampled	5/5/98	5/5/98	5/5/98	5/6/98	5/6/98	5/6/98	5/6/98	5/6/98
Date Extracted	5/11/98	5/11/98	5/11/98	5/11/98	5/11/98	5/11/98	5/11/98	5/11/98
Date Analyzed	5/20/98	5/14/98	5/19/98	5/20/98	5/20/98	5/23/98	5/23/98	5/23/98
Dilution Factor	2	1	1	1	1	1	1	1
Percent Solids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
QC Identifier	None	None	None	None	None	Field Duplicate 1	None	Field Duplicate 1
Phenol	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Bis(2-Chloroethyl)ether	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Chlorophenol	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Methylphenol	20 U	10 U	10 U	10 U	10 U	10 UJ	10 UJ	10 UJ
2,2'-oxybis(1-Chloropropane)	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
N-Nitroso-di-n-propylamine	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Hexachloroethane	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Nitrobenzene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Isophorone	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4-Dimethylphenol	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Bis(2-Chloroethoxy)Methane	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Naphthalene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Chloro-3-methylphenol	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	20 U	10 U	10 U	10 U	10 U	10 UJ	10 UJ	10 UJ
2,4,6-Trichlorophenol	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4,5-Trichlorophenol	50 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U
2-Chloronaphthalene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	50 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U
Dimethylphthalate	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
3-Nitroaniline	50 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U
Acenaphthene	20 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrophenol	50 U	25 U	25 UJ	25 U	25 U	25 UJ	25 UJ	25 UJ
4-Nitrophenol	50 U	25 U	25 U	25 U	25 U	25 UJ	25 UJ	25 UJ

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; EB/TB - Equipment/Trip Blank contamination

Aqueous Semivolatile Organic Analysis (ug/l)
Site: Derecktor Shipyard Outfall Sampling
Case: 7752; SDG: OF0401

EPA Sample Number	DSY-OF04-01		DSY-OF05-01		DSY-OF06-01		DSY-OF07-01		DSY-OF08-01		DSY-OF09-01		DSY-OF09A-01		DSY-OFDUP-01	
Station Location	DSY-OF04-01		DSY-OF05-01		DSY-OF06-01		DSY-OF07-01		DSY-OF08-01		DSY-OF09-01		DSY-OF09A-01		DSY-OFDUP-01	
Date Sampled	5/5/98		5/5/98		5/5/98		5/6/98		5/6/98		5/6/98		5/6/98		5/6/98	
Date Extracted	5/11/98		5/11/98		5/11/98		5/11/98		5/11/98		5/11/98		5/11/98		5/11/98	
Date Analyzed	5/20/98		5/14/98		5/19/98		5/20/98		5/20/98		5/23/98		5/23/98		5/23/98	
Dilution Factor	2		1		1		1		1		1		1		1	
Percent Solids	0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
QC Identifier	None		None		None		None		None		Field Duplicate 1		None		Field Duplicate 1	
Dibenzofuran	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
2,4-Dinitrotoluene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Diethylphthalate	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
4-Chlorophenyl-phenylether	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Fluorene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
4-Nitroaniline	50	U	25	U	25	U	25	U	25	U	25	U	25	U	25	U
4,6-Dinitro-2-methylphenol	50	U	25	U	25	U	25	U	25	U	25	U	25	U	25	U
N-Nitroso-diphenylamine	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
4-Bromophenyl-phenylether	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Hexachlorobenzene	20	UJ	10	U	10	UJ	10	UJ	10	UJ	10	UJ	10	UJ	10	UJ
Pentachlorophenol	50	U	25	U	25	U	25	U	25	U	25	U	25	U	25	U
Phenanthrene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Anthracene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Carbazole	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Di-n-Butylphthalate	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Fluoranthene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Pyrene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Butylbenzylphthalate	78		10	U	3	J	10	U	10	U	4	J	10	U	5	J
3,3'-Dichlorobenzidine	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Benzo(a)anthracene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Chrysene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
bis(2-Ethylhexyl)phthalate	20	U	10	U	1	J	10	U	10	U	10	U	10	U	10	U
Di-n-octylphthalate	20	UJ	10	U	10	U	10	UJ	10	UJ	10	U	10	U	10	U
Benzo(b)fluoranthene	20	U	10	U	1	J	10	U	10	U	10	U	10	U	10	U
Benzo(k)fluoranthene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Benzo(a)pyrene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Indeno(1,2,3-cd)pyrene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Dibenzo(a,h)Anthracene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Benzo(g,h,i)Perylene	20	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; EB/TB - Equipment/Trip Blank contamination

Aqueous Pesticide/PCB Analysis (ug/l)
Site: Derecktor Shipyard Outfall Sampling
Case: 7752; SDG: OF0401

EPA Sample Number	DSY-OF04-01		DSY-OF05-01		DSY-OF06-01		DSY-OF07-01		DSY-OF08-01		DSY-OF09-01		DSY-OF09A-01		DSY-OFDUP-01	
Station Location	DSY-OF04-01		DSY-OF05-01		DSY-OF06-01		DSY-OF07-01		DSY-OF08-01		DSY-OF09-01		DSY-OF09A-01		DSY-OFDUP-01	
Date Sampled	5/5/98		5/5/98		5/5/98		5/6/98		5/6/98		5/6/98		5/6/98		5/6/98	
Date Extracted	5/11/98		5/11/98		5/11/98		5/11/98		5/11/98		5/11/98		5/11/98		5/11/98	
Date Analyzed	5/13/98		5/13/98		5/13/98		5/13/98		5/13/98		5/13/98		5/13/98		5/13/98	
Dilution Factor	1		1		1		1		1		1		1		1	
Percent Solids	0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
QC Identifier	None		None		None		None		None		Field Duplicate 1		None		Field Duplicate 1	
Aroclor-1016	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Aroclor-1221	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U
Aroclor-1232	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Aroclor-1242	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Aroclor-1248	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Aroclor-1254	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Aroclor-1260	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; EB/TB - Equipment/Trip Blank contamination